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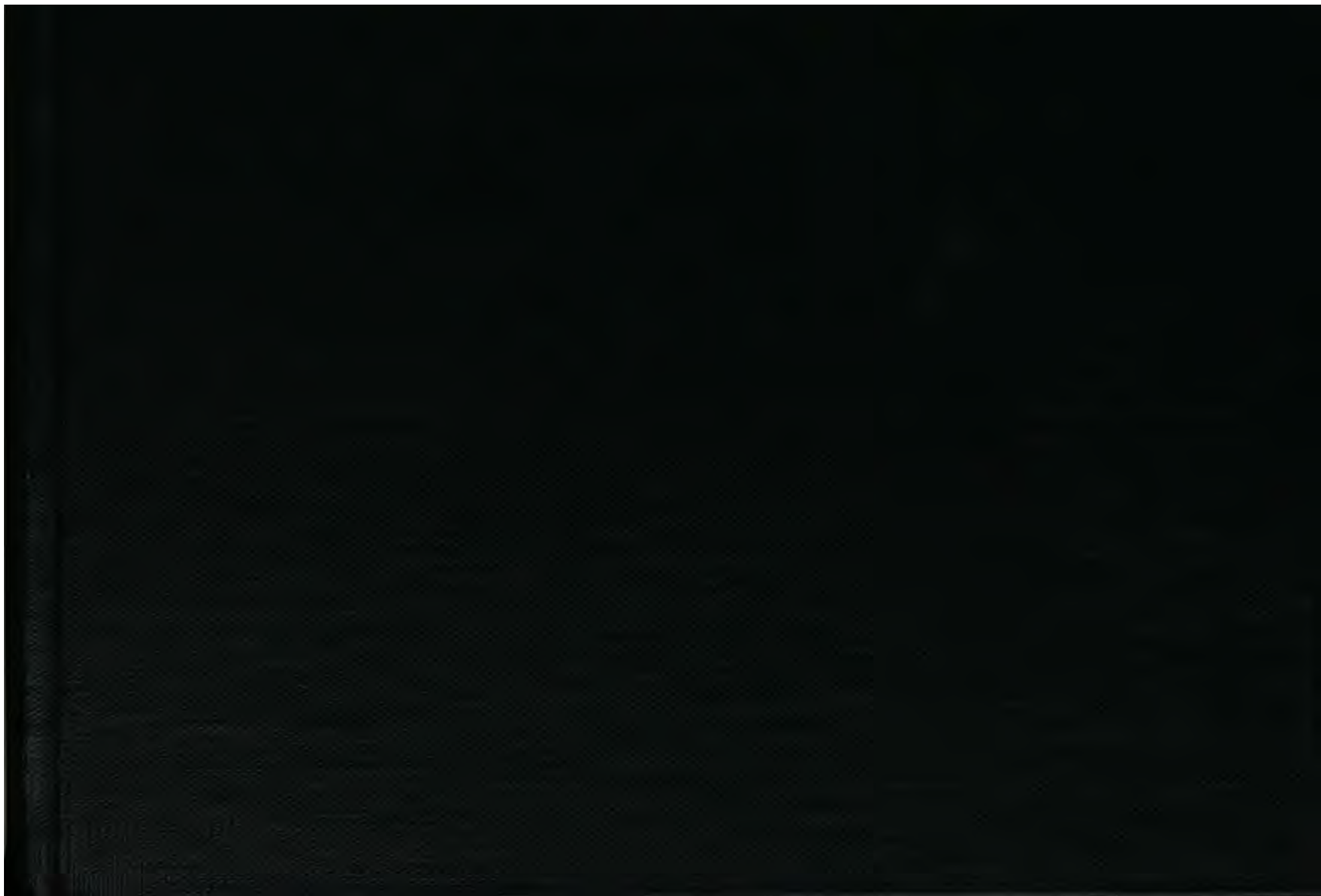
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PLAIN OF THE

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A TEXT-BOOK
ON
PLAIN LETTERING

BY
HENRY S. JACOBY,
PROFESSOR OF BRIDGE ENGINEERING IN CORNELL UNIVERSITY.

THIRD THOUSAND.

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PREFACE.

This volume has been prepared to meet the need of the technical schools for a text-book which should give a detailed treatment of the Roman, Gothic, and some other styles of plain letters which are suitable for engineering and architectural drawings.

The Roman letters are used in the discussion of the principles of proportioning and of spacing, since their main elements form the basis of the other styles shown, and the methods which are developed for the former also apply to the latter with but little, if any, modification. The system of measurements which has been adopted is such that the proportions are expressed in terms of a convenient unit, and permit letters of the normal as well as of other relations between width and height to be constructed with equal facility. The measurements are the result of a careful study of the form of each letter in comparison with the others in the alphabet, and of a critical examination of the best available models.

This is believed to be the first attempt to reduce spacing to a definite system which enables any draftsman at once to make the final location of the letters. In spacing, the same scale is employed as in proportioning, and all the spacing guides for the most useful styles of letters are indicated in a table covering a single page of the text.

The detailed description of the methods of proportioning and spacing and of the various changes in form and details by which given results are obtained, are so completely illustrated that the full significance of each statement may be comprehended without an undue expenditure of time. In writing the description, the wants of students who are in schools where the instruction in lettering is limited to that on the drawings required in other courses of study, have also been kept in mind. In some of the leading technical schools the importance of lettering is recognized by a separate course of instruction.

Ornamental letters are excluded, because they are but

seldom required by engineers and architects and constitute the principal part of the contents of most of the books on alphabets heretofore published.

Plates I-XXIII were reproduced by photo-engraving from drawings made by the author. While the engraving and press-work give evidence of unusual skill and care, it may be well to state for the benefit of those who will examine these plates critically, that the extremities of some of the serifs were drawn a little too light on several of the plates on which no dimensions are given, and hence were slightly shortened in the mechanical process of reduction.

The kind co-operation of a number of architects and engineers is gratefully appreciated, and is duly acknowledged in the text. Special mention, however, is due to Professor

C. FRANCIS OSBORNE, of Cornell University, for valuable suggestions relating to lettering for architectural drawings; to EDWARD MOLITOR for his excellent drawing, illustrating map lettering; to the Superintendent of the United States Coast and Geodetic Survey for permission to use the standards of lettering adopted by the Survey; to HENRY GANNETT, the Chief Topographer of the United States Geological Survey, for similar permission; to the Secretary of the Mississippi River Commission and to Colonel O. M. POE, Corps of Engineers, U. S. Army, for permission to use portions of charts prepared under their respective directions.

HENRY S. JACOBY.

Ithaca, N. Y., August 19, 1895.

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PLAIN LETTERING.

CHAP. I. THE CONSTRUCTION OF LETTERS.

ART. I. THE ELEMENTS OF LETTERS.

All letters are composed either of straight lines or curves, or of a combination of both. Since letters ought to be pleasing to the eye, the curves should be lines of beauty. In nature, curves are of continuously varying curvature, the different forms of spirals constituting a prominent class. Many of the curves of letters must, however, be symmetrical with reference to an axis, and must either close or be tangent to parallel lines, and the simplest curve of varying curvature which will meet this requirement is the ellipse. The letter S, which in its elementary forms has been called the line of beauty, may be considered as a combination of a sinusoid with ellipses, or even of two or more ellipses tangent to each other.

Theoretically, then, the forms of letters which are perfect

from an artistic point of view are composed of right lines in combination with plane curves of the second or higher orders, but practically it is desirable to substitute, within reasonable limits, one or more arcs of circles for an ellipse to facilitate the construction by means of dividers. When the letters are small a single circle may well replace an ellipse in case its axes are nearly of the same length. While drawing the freehand curves, however, it is well to bear in mind the artistic value of variable curvature.

Every student and draftsman is supposed to have had some practice in freehand drawing before he takes up the subject of lettering, so that his eye has been trained to detect irregularities in curvature, and his hand to have such steadiness in drawing a line that he can readily secure the desired result.

ART. 2. GENERAL PROPORTION.

In order to show the relative influence of the elements which determine the proportion of a letter, let the modern Roman capital H be taken, which consists of two vertical body strokes or stems, united by a horizontal light line, the stems being surmounted by caps and resting upon bases. Both caps and bases are technically called serifs.

The middle letters of the four lines in Fig. 1 are exactly the same in every respect. In the first line the letters are of the same width, the stems are one-fifth as wide as the letters, and the heights are respectively 4, 5, 6, 7 and 8 times the width of the stems. In the second line the centers of the stems are the same distance apart as before, and the height is the same throughout, while the stems vary in width as $1\frac{1}{2}$, $1\frac{1}{4}$, 1, $\frac{7}{8}$ and $\frac{3}{4}$. If the exterior width of these letters remained the same, the difference in effect would be comparatively slight for the two left-hand letters, and would not be noticed at all in the right-hand ones. Unless otherwise stated, the width of a letter is to be exclusive of its serifs. In the third line the width and height are uniform, and the widths of the stems are respectively $\frac{2}{3}$, $\frac{3}{4}$, $\frac{4}{5}$, $\frac{5}{6}$ and $\frac{2}{3}$ of the width of the letters. The width of the inclosed space here varies as 1, 2, 3, 4 and 5. In the

fourth line the letters have exactly the same proportions as in the first, but are reduced to a uniform height.

The differences between the corresponding stems in the

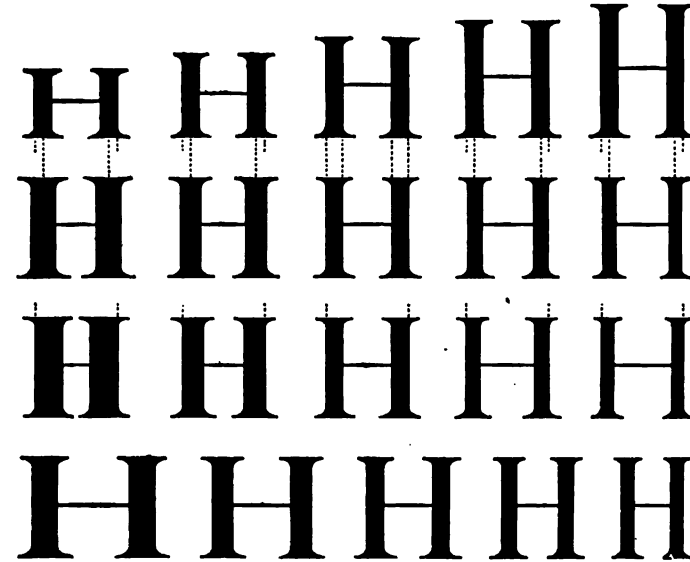


Fig. 1.

second, third and fourth lines are not perceptible except in the case of the left-hand letter of the third line, which is about ten per cent heavier than either the one above or

below it, which difference becomes apparent, however, only when the letters are drawn to a larger scale.

A comparison of the second, third and fourth lines shows that the relative width of the inclosed space has a considerable influence on the appearance of the letter, and that only comparatively slight changes can be made in the width of stem without requiring a corresponding modification of the exterior width of the letter. This is true in a greater degree when increasing than when decreasing the width of stem. In general it may be said, that in letters of the same height the width of stem varies directly as the width of letter. It is seen, therefore, that the width of stem depends chiefly on the width of the letter, although it has been customary to state the width of stem in terms of the height only.

From the above illustration it is concluded that the letters may be most conveniently proportioned and constructed by means of a scale whose unit is the width of stem. The width of any given letter may thus be expressed by a number which shall be constant for the same style, irrespective of its actual size. In determining the exterior width, due regard is to be paid to the width of the inclosed space. The height may also be conveniently expressed in terms of the same unit of measure, although this is not absolutely necessary. In case it is desired to construct lighter or

heavier letters than what may be termed the standard, the scale may remain unchanged, while the stems are made less or more than one unit wide.

The general proportion, accordingly, depends upon four elements: first, the height; second, the width, including its extreme width as well as that of its main body; third, the weight or width of its parts; fourth, the inclosed space. The best effect is produced when these elements are so harmonized that no one shall appear to predominate. In Fig. 1 those on the left of the middle series may be called heavy, while those on the right are light. In the fourth line the two letters at the left are known as extended, and the two on the right as condensed letters, the middle letter having what might be called the normal proportion.

The height may range from 3 to 10 or 12 units, and the width of stem from $1\frac{1}{2}$ to $\frac{1}{2}$ unit or less. These limits should rarely, if ever, be exceeded on drawings, although type forms extending far beyond them are in general use. Methods of varying the general proportions, and their application, will be illustrated in subsequent articles.

ART. 3. RELATIVE PROPORTION.

In order that a given number of words may have the maximum legibility, it is necessary that all the letters have

simple forms, but shall be readily distinguished from one another, and that the general appearance of the combined form and arrangement of the letters and words shall be as uniform as possible. This general uniformity implies uniformity of the same degree in every word, or, no letter should appear more prominent than another, and thus attract undue attention to itself when the word is observed in the process of reading. Legibility depends upon the spacing as well as the forms of letters, but only the latter will be considered in this chapter.

The characteristic features of the principal styles of letters like those of the Roman and Gothic alphabets have been established by usage. The proportions of the letters, however, are not absolutely fixed, but are varied within certain limits, according to the taste of the designer. It is desirable, therefore, that within these limits such proportions should be adopted as still further to promote legibility, and at the same time, if possible, to secure convenience of construction.

The different letters of the alphabet must be given such relative dimensions that their actual heights, widths, areas of inclosed spaces, and weights of parts shall be combined to produce the uniform effect above mentioned. The importance of this statement may, perhaps, be emphasized by a reference to Fig. 2. The horizontal hair-lines on H and E

are placed at mid-height, and yet they appear to be a trifle below the middle. The upper and lower spurs on the right side of E are of exactly the same size, but the upper one



Fig. 2.

looks to be slightly larger than the lower. The width of E is the same at the top as at the bottom, but appears to be just a little wider at the top. The height of O is the same as that of the other letters, but it seems to be less. The widths of H, D and O at the middle are equal, but their apparent widths decrease in the same order. N has the same width as H, but it seems to be spread out too much in comparison. The middle of the curved stem of the O and the widest part of each spur of E appears to be narrower than the stem of H, although the measured width is the same.

It is seen from these illustrations that optical reasons materially affect the design of letters. Let the student cultivate the habit of noticing the relative proportion of letters displayed on signs and posters as well as on drawings.

ART. 4. ROMAN CAPITALS.

The modern form of the Roman capitals will be used to illustrate the analysis of those relative proportions which, with but slight modification, may be applied to nearly all of the simpler and more useful styles of letters. This form is more frequently employed by draftsmen, and hence more familiar than the old style, from which it differs chiefly in having a greater disparity in the weight of its heavy and light lines, and to some extent, also, in the details of the serifs. The modern form is the result of modifications mainly introduced in the eighteenth century by some English type-founders.

In the following analysis the alphabet will be divided into three groups: the rectangular, diagonal and curved letters. There are comparatively few parts requiring vertical measurements, and these can readily be drawn by means of three horizontal guide lines in addition to the two which limit the height of the letters. One of these intermediate lines is placed at mid-height, and the other two at one-third and at two-thirds of the height, respectively.

RECTANGULAR LETTERS.

The letter H (Fig. 3) is taken as the standard of comparison for the whole alphabet. Using the width of the stem

as the unit of measure, the width will be taken at five and the height at six units, the same proportion as that given for the middle letter of each line in Fig. 1. The two verti-

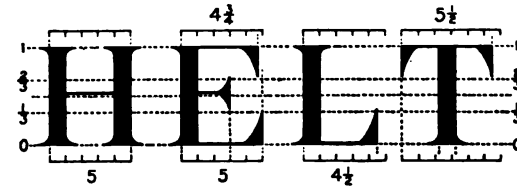


Fig. 3.

cal stems are joined by a horizontal light line, which for optical reasons must be placed just a little above the mid-height. The hair-lines of the serifs project three-quarters of a unit beyond the edges of the stems at the bottom, and about one-eighth unit less at the top. If both were made exactly the same length, the caps would appear longer than the bases. Of course if the letters are small, no difference in the serifs need be attempted. The serifs are completed by connecting the hair-lines to the stems by means of small curves which correspond to the apophyge of a column. The curves are sometimes omitted in very small letters, but not without detracting from their appearance.

The letter I corresponds to one stem of H in every respect.

E consists of a vertical stem, three horizontal light lines and three hooks or spurs. As the right side of the letter is not as heavy in appearance, it would be made somewhat narrower than H if the central spur were omitted; but as the latter reduces the interior space, the width of the lower part will be made the same as for H or 5. For optical reasons the upper width is reduced to $4\frac{3}{4}$. The intermediate line occupies the same position as in H, and the right side of the central spur is half-way between the right side of the stem and the lower spur, or two units from the stem. The ends of the spurs are located just a little above the guide lines, thus making the upper one smaller than the lower, as it should be. The inner edges of the spurs are smooth curves, usually drawn freehand. The upper spur is made one unit wide, the lower one $1\frac{1}{8}$ units, and the central spur $\frac{3}{4}$ unit. The serifs have curves only on the left of the stem.

F is exactly the same as the corresponding part of E.

L has the same form as the corresponding part of E, but having no central spur it is made a half unit narrower, making the width $4\frac{1}{2}$.

T has a central stem with a horizontal light line resting upon it and a spur attached to each end of the latter. The

spurs are of the same size as the upper one on E. The width is $5\frac{1}{2}$, or as much wider than H as L was narrower.

DIAGONAL LETTERS.

N has two vertical light lines united by a diagonal stem of unit width. As the sides are lighter than in H, its width is reduced to $4\frac{1}{2}$. The upper extremity of the stem extends a little to the left of the light line, so as to be tangent

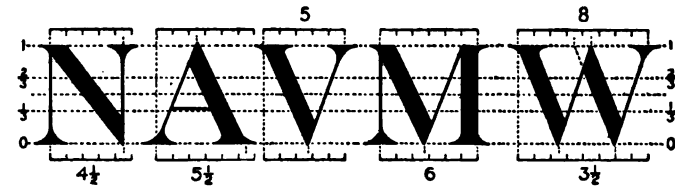


Fig. 4.

to the curve of the serif, while its lower extremity is pointed and must extend a little below the guide line in order that the right side of the letter may appear to have the same depth as the left. All other letters having such points must be similarly treated. The serifs attached to the hair-lines are larger than when connected with stems, in order to balance the letter. The projection on each side of the limb is $\frac{7}{8}$ for the upper and one unit for the lower serif.

In A an inclined hair-line is joined to an inclined stem,

forming a pointed top, which extends a little beyond the upper guide line. The width is $5\frac{1}{2}$, being measured from the points where the inclined outer edges of the letter intersect the lower guide line when produced. In order that the two sides may appear to have the same inclination, the apex must be moved just a little to the left of the center line, so as to increase the slope of the line. It might be sufficient, in letters of the normal proportion, to move the apex $\frac{1}{8}$ unit, but, in order to use the same value for all heights and for convenience, the horizontal component of the light line is made $2\frac{1}{2}$, while that of the outer edge of the stem is 3. The two sides are united by a horizontal line placed just a little above the $\frac{2}{3}$ guide line. Where the hair-line of the serif makes an acute angle with a stem or light line, its projection is increased $\frac{1}{8}$, and on the obtuse angle it is diminished the same amount.

V may be regarded as an A without the horizontal line, after rotation through an angle of 180 degrees. As the width is now measured at the top instead of at the bottom, as before rotation, it will be diminished a quarter unit, and also an additional quarter unit because V contains no horizontal hair-line. The width is thus reduced to 5. The horizontal component of the inclined light line is $2\frac{1}{4}$.

M is formed from V by adding a vertical light line at the

left and a vertical stem at the right. The width is therefore increased to 6. It should be observed that the vertex of the V is not midway between the vertical sides, but one-quarter unit to the right of this position.

W consists of two V's, but in order to avoid an excessive width, each V is contracted a half unit. The upper part of the second stem, which lies on the left of the light line, is preferably omitted. The width at the top is 8 and at the bottom $3\frac{1}{2}$. The horizontal component of each hair-line is 2.

In X the light line and stem cross each other near the middle. The left extremities of the stem and light line lie in the same vertical. The width at the top is 5 and at the bottom $5\frac{1}{2}$. Where the sides are inclined instead of vertical, as in E, the difference between the upper and lower

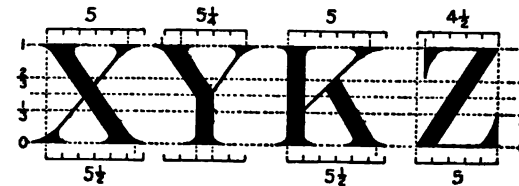


Fig. 5.

widths must be about twice as great, in order to produce the same apparent effect. It will be observed that the hori-

zontal component of the light line is a half unit less than that of the stem, which meets the condition imposed by the optical effect as noted in the case of A.

The upper part of Y is similar to that of X, but has slightly different dimensions to facilitate construction. Its lower part is the same as that of I. The width of the top is about $5\frac{1}{4}$. The light line meets the stems just a little above the middle guide line, and its horizontal component is 2.

In K the diagonal light line meets the vertical stem near the $\frac{2}{3}$ guide line. The width of the letter is 5 at the top and $5\frac{1}{2}$ at the bottom. The outer edge of the inclined stem bisects the light line, and hence meets it near the $\frac{2}{3}$ guide line. This letter may also be regarded as derived from X.

Z is an exceptional letter in some respects, but may be considered as a reversed S (see Fig. 7), with angles substituted for the curves. The width is $4\frac{1}{2}$ at the top and 5 at the bottom. The spurs are the same size as in E. The right extremity of the stem is in the same vertical as the edge of the lower spur. The stem is similar to that of the X, but is reversed in direction. It is the only diagonal stem which slopes downward toward the left. This fact should be thoroughly fixed in the mind of every student.

CURVED LETTERS.

The letter Q differs from an O by the attachment of a short limb of reversed curvature. The outer curve of the O should be strictly an ellipse, but for a height not much over an inch two arcs of circles joined by short tangent curves will answer the purpose. In order that this letter may appear as large as H it must be made somewhat wider. A width of 6 will be adopted. The centers of the arcs are



Fig. 6.

shown on the middle vertical. On Plate I the centers are placed on the middle guide line and the arcs joined at the top and bottom. For optical reasons the letter must project a little beyond the upper and lower guide lines. As the sides vary in thickness they should be a little wider at the center than a stem of uniform width—say about $1\frac{3}{8}$ units. The interior curve is elliptical, but by practice can readily be drawn freehand. The vertical tangents to the

curve facilitate its construction. The light part at the top and bottom should be about 2 units long. If the size is small—say less than $\frac{3}{8}$ or $\frac{1}{4}$ inch—the letter may be made a full circle. The appendage of the Q extends $3\frac{1}{2}$ units from left to right and extends $\frac{3}{4}$ unit above and $1\frac{1}{2}$ units below the lower guide line. Its width or thickness is $\frac{7}{8}$. The one on Plate I has a thickness of one unit and projects one unit below the guide line. It would be improved if its thickness were reduced to $\frac{3}{4}$. The form in Fig. 6 is to be preferred. Sometimes the appendage is lowered until its upper edge is tangent to the body of the letter.

The left half of the C is the same as that of the O. The spur is the same size as that on E, but has a curve on its upper side. The upper width of the letter is $\frac{1}{4}$ unit less than the lower. It will be noticed that the right-hand part of the lower curve has a smaller radius than the left.

G has the same widths as C, and differs from it only in the substitution of a short stem for the corresponding hair line. This stem extends upward to midway between the $\frac{2}{3}$ and $\frac{1}{2}$ guide lines, and is united to the lower light line by suitable curves, as shown in the figure. On Plate I it is shown as extending only a little above the $\frac{1}{3}$ guide line.

D may be regarded as the combination of E without its spurs and the right half of O. The width is $5\frac{1}{2}$.

U consists of a vertical stem and a light line, united below by means of a semi-circular curve tangent to the center line of the stem, and into which the stem tapers by tangent curves drawn freehand. The right hand serif has the same size and form as the corresponding one on N. The width is $4\frac{1}{2}$, or the same as N and L.

J is like a part of U reversed, the lower line being constructed in a similar way. Its left end is tangent to a circular bulb, whose diameter is a little larger than unity, and which extends just a little above the $\frac{1}{3}$ guide line. The width of the letter is 4.

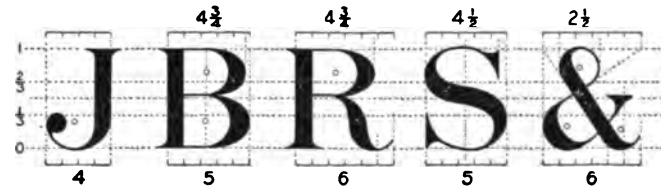


Fig. 7.

B may be derived from E by substituting for its three spurs two curved tapering stems tangent to its horizontal light lines. The inner edges are circles and the outer edges elliptical curves. If the center lines are circular the letters will appear too full at the middle, where the two curved stems are tangent to each other.

The widths of B are $4\frac{3}{4}$ and 5, or the same as those of E.

R differs from B in replacing the lower curved stem by a stem of reversed curvature. The center of gravity of the two curved stems should be in the same vertical, and therefore the lower one should be tangent to the middle hair line a little farther to the left than the upper one, and it should taper into a light line at the bottom approximately in a vertical tangent to the upper curved stem. The width at the bottom is 6. On Plate I the form is given when the width is reduced to $5\frac{1}{2}$.

P is exactly the same as the corresponding parts of B and R.

S is made $4\frac{1}{2}$ wide at the upper part and 5 at the lower. In constructing this letter, first draw the vertical sides of the spurs, then draw the upper and lower light lines, the short curves to complete the spurs, and finally the tapering curved stem. The upper portion of the stem should appear to be tangent to the vertical through the left side of the lower spur, and for optical reasons the curve ought to extend a little beyond this vertical. Such a position should be taken by the draftsman that the general direction of each principal portion of such curves may be drawn toward himself.

The symbol & has a width of $2\frac{1}{2}$ at the top and 6 at the bottom. The vertical tangents on the left of the upper and

lower parts of this symbol are one unit apart. The foot extends a little higher than the middle guide line. The auxiliary construction lines and centers of the circular arcs are shown in the figure.

ART. V. GENERAL DETAILS OF CONSTRUCTION.

The following is a summary of the general details given in the preceding article and arranged in order for convenient reference. They should be committed to memory by the student.

1. All letters having distinct upper and lower parts require the upper to be somewhat smaller in size than the lower one. The upper width of the letter is to be less than the lower, the contraction being made only on the right side, except in the cases of Z, where it is made on the left side, and of &, where it is made on both sides. The height of the upper spurs is to be a little less and that of the lower a little greater than one-third of the height of the letter.

2. Curved tops or bottoms of letters should extend slightly beyond the upper and lower guide lines. Pointed parts must likewise be extended.

3. Intermediate horizontal light lines are placed a little above mid-height in all cases except in A, where it is similarly placed with respect to the $\frac{1}{3}$ guide line.

4. All diagonal stems slope downward toward the right, except that of Z.

5. When the end of a diagonal light line joins that of a diagonal stem, the slope of the light line must be a little steeper than that of the stem.

6. Curved stems continuously varying in width must be broader at the middle than those of uniform width.

7. The thickness of the light lines should generally not be less than one-eighth of the stem. While this is the customary thickness, it would be better to increase it to one-sixth, and, in very small letters, to one-fourth of the stem. The light lines should always be distinct and clear, as the individuality of letters depends upon it to some extent.

The projections of all the serifs beyond the lines to which they are attached are given in Fig. 8. On Plate I, the

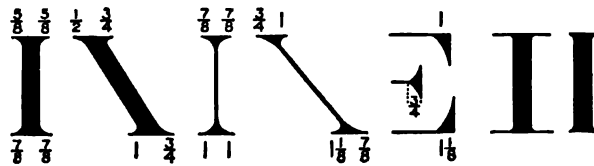


Fig. 8.

Fig. 9.

curves are made smaller than in Figs. 3 to 7. The effect of small curves may be seen on plate IX, while that of larger

curves is shown on plates XIV and XV. Let the student construct the letters of the same word in two lines, making the serif curves in one line small and in the other large, and carefully observe the difference between the general expression of the two words.

The extreme forms of the serifs are given in Fig. 9, those on the left hand I projecting more than a unit, while those on the other I are very short, the curves in both cases being small. The former is known as the French and the latter as the Elzevir, while the serifs in Fig. 8 are of the Scotch style.

In addition to avoiding small curves at the serifs, the student is also cautioned against making the light lines too thin and against shortening the tapering portions of the curved limbs.

The Roman capitals, whose construction was described in the preceding article, should first be drawn in pencil with such care and precision that the process of inking will consist merely in following the pencil lines. Until a draftsman has, by patient practice, secured such a firm control of his hand as to make smooth curves of uniform width of line with precision, he should not attempt to correct and complete outlines with the pen which were defectively sketched with the pencil.

If the construction is made on plain paper the horizontal

guide lines should be drawn lightly with a finely-pointed pencil and the widths may be conveniently laid off by the aid of a small paper scale about 10 units long, with one unit on the left of the zeropoint divided into quarters.

After constructing the letters to a large scale like that shown on Plate I they may then be drawn to about one-half of that scale. When the letters are quite small some features must be proportionately exaggerated, such as extending the curves and pointed stems beyond the guide lines, and enlarging the curves at the caps and bases.

By carefully comparing the widths of the letters which are shown on Plate I in alphabetical order, and observing the reasons given in the preceding article for the differences in width, they will more easily be fixed in the memory.

In inking letters the following order of procedure should be observed: First, draw the arcs of circles; second, the straight lines, including light lines and edges of stems; and third, the freehand curves. The arcs of circles should be drawn before the right lines, to some of which they are tangent, as it is a well-known rule in drawing that all curves constructed by dividers should precede their tangents. After the outlines are completed the letters may be filled in with a pen, but this should not be done until all the pencil lines have been erased and the drawing cleaned. In this way the

heavy black lines of the letters will remain unimpaired, which if subjected to the eraser would assume a grayish appearance.

A set of the finished capitals is shown on Plate IV, the scale being one-half of that used in Plate I, the height increased to seven units and the stems reduced to $\frac{3}{8}$ unit.

ART. VI. ROMAN SMALL.

The small letters, which are called lower-case letters by printers, are divided into three groups: first, those whose height is the same as those of the capitals and limited by the same extreme guide lines, b, d, f, h, k and l; second, those whose height is the same as the preceding, but which project below the lower guide line, g, j, p, q and y; and third, those whose height corresponds to that of the main body of the preceding groups, a, c, e, i, m, n, o, r, s, u, v, w, x and z (see Plate II). These three classes are sometimes designated as ascending, descending and short letters, respectively. The first thing to determine, therefore, is the ratio of the height of the short letters to that of the others, or of the capitals. This ratio has sometimes been taken as one-half, but more frequently as two-thirds. J. ENTHOFFER, in his *Manual of Topography*, employs what is called the "golden cut," taken from the theory of the proportions of the human

body, developed by Professor Dr. A. Zeising, in a work published in 1854. The golden cut of any line is such a division that the lesser segment is to the greater segment as the greater segment is to the whole. If l denotes the length of a line and x its larger segment, this relation is expressed by

$$l-x : x = x : l,$$

the solution of which gives $x = 0.618l$. In the reduction of the equation $x + \frac{1}{2}l = \sqrt{1.25}l$ was obtained, and which indicates a convenient graphic method for finding x . In Fig. 10 lay off ab equal to l , and ac perpendicular to ab and equal to $\frac{1}{2}l$. With c as a center, describe the arc ad , and with b as a center, describe the arc de , then be is equal to x , or 61.8 per cent of ab .

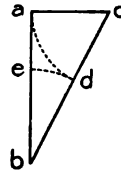


Fig. 10.

The thickness of the stems of all the small letters for the normal or standard proportion is given the same relation as that used for the capitals, and therefore it will be 61.8 per cent of that of the capitals. Practically, it will be near enough to take 0.6 as the ratio. This thickness of stem will be adopted as the unit in proportioning the small letters.

In Fig. 11 the word *Armor Plate* is drawn with the height of its short letters equal to one-half, six-tenths, and two-

thirds, respectively, of the height of the capitals, as an illustration of the effect due to this relation alone.

It is evidently very desirable that as little difference should

Armor Plate Armor Plate Armor Plate

Fig. 11.

be made between the proportions of the small letters and the corresponding capitals as is allowable on account of change in form.

Six guide lines are required for small letters. The lines a and e in Fig. 12 are the top and bottom guide lines of the capitals. The line b is drawn so that be equals six-tenths of ae , and ef is made equal to ab . Lines d and c are at one-fourth and three-fourths of the height be respectively. The round letters will need an additional guide line midway between the lines c and d .

As many of the small letters have the same form as the corresponding capitals, only those details will be referred to in the following description which are different.

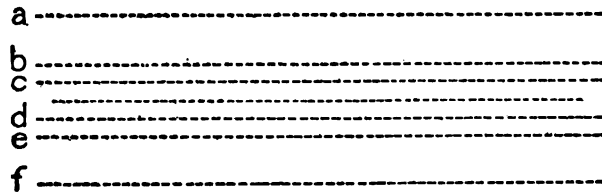


Fig. 12.

All curves tangent to vertical stems will meet them at or near the guide lines *c* and *d*, marked $\frac{3}{4}$ and $\frac{3}{4}$ on Plate II. The form of these curves should be elliptical. For the sizes most frequently employed they are drawn freehand, but for larger ones a circular curve may conveniently be constructed either to replace an elliptical hair line or an edge of a stem, or to serve as a guide line for the freehand curves.

The letter *h* is taken as the basis of the series, similarly to the capital, its width being 5. The edges of the curved stem are to be tangent to the circular hair line, which in turn is tangent to the edge of the long stem, and also when produced to the center line of the other stem. The position of the center of this arc is shown on the plate by a small

circle. The serifs have the same relative size as in the capital letters, but in small-size letters their projection is often increased to one unit; unless the scale is large, however, the upper serifs are made of the same size as the lower.

The *n* is equal to a portion of *h*; *m* becomes a double *n*, and, therefore, has a width of 9, while *u* is like a rotated *n*, with slight modifications in its serifs. The *l* is like the long stem of the *h*, and *j* is equal to the left stem of the *n*, with the addition of a circular dot, whose center lies one-third of the way between the guide lines $1\frac{2}{3}$ and 1. When the scale is very small, however, the dot is sometimes placed on the upper guide line. The *j* may be obtained from the *i* by producing its stem downward and tapering it into a curved hair line, which is tangent to a bulb whose center has the same relation to the $-\frac{2}{3}$ guide line as the dot has to the $1\frac{2}{3}$ guide line. The outer edge of the stem and the hair line may be composed of two tangent quarter circles, whose radii are $2\frac{1}{2}$ and $1\frac{1}{2}$ respectively. The *f* is the same as *j* after rotation, with the addition of another lower foot and of a cross line on the guide line 1. The width of *j*, *f* and *r* is 4.

The *t* has a cross line like the *f*, but its stem extends only half way from this cross to the upper guide line, and is cut off obliquely, while the lower end of the stem is tapered

off into a curved hair line, the latter being a semi-circle tangent to the outer edge of the stem.

The y is a v, with its hair line extended downward and curved so as to be tangent to a bulb in a vertical line one unit beyond the left construction line for the upper part of the letter, and whose center is about one-fourth of the way between guide lines $-\frac{2}{3}$ and o.

The spur of c is changed to a bulb tangent to the curved hair line. The e is derived from the o by introducing a horizontal hair line about one-third of the way from the $\frac{1}{2}$ to the $\frac{3}{4}$ guide line and omitting a part of the right-hand stem. The upper part is contracted a little so as not to be wider than the lower part. The letters b, d, p and q have the same width, and differ but slightly in composition. They may be regarded as a combination of a part of h with one-half of the o.

No small letter differs from its capital form more than g. It consists of an o about five units wide, lying between the guide lines $\frac{3}{4}$ and 1, united to a curved stem resembling the larger portion of an S whose sides extend $\frac{1}{2}$ unit beyond the upper o. A small projection, consisting of a bulb and a tangent connecting curve, is added on the upper right of the letter. In very small letters this projection must be relatively exaggerated in prominence.

The a has a bulb like the c, and its right-hand stem terminates below like the t. The upper curves of the letter are constructed like those of the h or n. The remaining details are shown on the drawing. It may be well to add that the upper serifs when attached to vertical stems extend only toward the left, except in the case of q, where the curve on that side prevents it. The horizontal cross lines of f and t on the upper guide line are not regarded as serifs. The lower serifs attached to vertical stems project on both sides unless prevented by adjacent curves, as in u and d. All serifs on diagonal stems or hair lines extend in both directions. The curved boundaries of letters should pass very slightly beyond the horizontal guide lines.

A complete set of the finished small letters in alphabetical order is shown on Plate IV, the scale being one-half of that used for the same letters on Plate II. The stems are reduced to a width of $\frac{1}{8}$ unit, while the height of the short letters is increased to 7 units, and of the others in the same ratio.

The letters a and t are the only ones which have short return curves at the base and if these curves were replaced by serifs it would not only simplify the construction but also the spacing. The appearance of the a when thus modified may be seen in the word Meridians on Plate XXI, and t is shown on the last line of Plate XIX, but in a lighter weight.

ART. 7. ITALICS.

The heavy and light lines and the axes of the entire letter and of its various parts, which are vertical in the Roman letters, are all inclined in the Italic, and the inclination of the sloping lines is correspondingly modified, as shown in Fig. 13. The intersection of any line of the letter with any horizontal guide line occupies the same position in the parallelogram as it did in the rectangle.

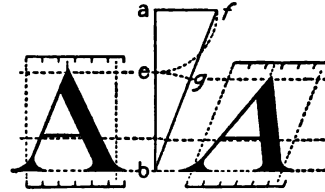


Fig. 13.

Mr. Enthoffer in his *Manual of Topography* takes the horizontal component af in Fig. 13, equal to ae , the smaller segment of the "golden cut" of the line ab . This makes the angle abf equal to $20^\circ 54'$. This angle may, however, be varied several degrees without producing a noticeable effect. If ab is laid off equal to 8 units and ac equal to 3 units the angle will be $20^\circ 33'$. On account of convenience in construction this value will be adopted instead of the other.

The height of italic letters is obtained by measuring along the slope bf and making the length bg equal to be , while the widths are laid off along the horizontal guide lines as before.

This arrangement causes italic letters to appear a little more slender than the Roman.

A complete set of the italic capitals and small letters is shown on Plate IV, the dimensions and the character of the details being exactly the same as for the Roman.

The horizontal component of the slope may be reduced to some extent without detracting from the general effect. Nearly all of the italics on Plate XXX have a base of $2\frac{1}{4}$ parts to a height of 8 parts, or an angle of $15^\circ 43'$ with the vertical. Alphabets have been published in which this angle was as high as 25° and in one instance even 30° . Let the student construct the same word four times in succession and give to their letters the slopes of $15\frac{3}{4}^\circ$, $20\frac{1}{2}^\circ$, 25° and 30° respectively and carefully compare their relative appearance.

ART. 8. STUMP WRITING.

Stump writing consists in such a modification of the italic small letters as to materially facilitate their freehand construction. This is chiefly accomplished by tapering off into curves the extremities of stems, transforming δ serifs and spurs into bulbs, and omitting ii serifs altogether. The remaining variations consist in more radical changes in the form of letters, as in the case of a , g and z . Slight irregularities in the

construction of this style are less noticeable and the general appearance of the letters is graceful.

The lower curved extremities of vertical stems extend $2\frac{1}{2}$ units beyond the outer edge of the stem, and the upper serifs project about 1 unit. The lower width of k is increased 1 unit on account of the curve attached to the diagonal limb of reversed curvature. The upper curves of diagonal stems, as in v, w and y, reach about $1\frac{1}{2}$ units beyond the point where the outer edge of the stem, if produced, meets their upper guide line. The width of v, w and y when measured between the points where their diagonals meet this guide is the same as for the Italic small, but as the bulbs are tangent to the diagonal hair lines at the three-quarter guide line the widths of these letters are thereby contracted a little on the right side when finished.

In x the stem is made vertical with curved extremities on both sides. The extreme widths are increased to 6 and $6\frac{1}{2}$. In z the diagonal stem is changed into a hair line and the horizontal hair lines combined with the spurs are altered into stems of reversed curvature, the widths being increased one-half unit.

As the right upper portion of e is rounded, its width as well as that of the lower part is reduced one-quarter unit. The form of a is made equal to d with the upper end of its

long stem removed, and g is derived from q by curving its long stem toward the left and reducing it into a hair line which is tangent to a bulb. The lower width is about one-half unit less than the upper.

When constructed freehand, unless the size is very small, it is best not to attempt to make the heavy strokes with one movement of the pen under pressure but to draw the edges of the stems and fill them in afterwards. This method secures greater uniformity in the thickness of the stems and also better curvature, since the pen when held lightly for the fine lines yields more readily to the movement of the hand.

As the right-hand limbs of h, m and n are curved at their ends in opposite directions they appear to have a slightly steeper slope than the adjacent straight stems, although their central parts are truly parallel. When these letters are drawn freehand many draftsmen find a tendency to give the right-hand stems a slope which is actually steeper, and therefore need to guard themselves against it.

On Plate IV the letters are drawn to one-half the above scale, filled in and arranged in regular order. The proportion is slightly different, however, the height being 7 and the width of stem $\frac{7}{8}$ unit. The capitals to be used in stump writing are the same as those used with the Italic small.

Alternate forms of the letters v, w and y are given in

Fig. 14. These are easier to space than the ones given on the plate, as they avoid diagonal lines and the curved extremities on the left. Sometimes the curves on the left of v, w and y, as drawn on Plate II, are replaced by serifs.



Fig. 14.

ART. 9. GOTHIC CAPITALS.

Gothic is an American term applied to letters whose form is similar to that of the Roman, but whose limbs are all of uniform width and without serifs. They are known in England as grotesque and sans-serif. Those called Gothic letters in England and on the Continent are black-faced, pointed letters, originated in the latter part of the twelfth century and improved in the succeeding century. In this country they are usually designated as black letter, or church text.

It will only be necessary to indicate in this article the particulars in which the construction of the Gothic differs from the Roman letters. Being composed of lines of uniform weight throughout, the width of the lines should be less than that of the stems or heavy limbs of the Roman or else an appearance of excessive weight will be produced. In Fig. 15 the same word is shown in Roman and in Gothic

letters, the latter being $\frac{1}{2}$ and 1 unit thick respectively. The upper word appears a little lighter and the lower one decidedly heavier than the Roman.



Fig. 15.

Gothic letters with a thickness of about $\frac{3}{8}$ would have about the same weight as the Roman whose stems are one unit wide.

Those shown on Plate III have lines which are half a unit wide. In order to preserve the same apparent proportions the widths of all the Roman capitals having an exterior light line on either side, including A, M, N, U, V, W, X and Y, must be increased about one-half unit for the Gothic style. For simplicity, however, the width of Y will be made $5\frac{1}{2}$, the same as V and X.

As the Gothic letters have no serifs and but comparatively few horizontal lines, it will be more convenient to limit the circular edges and the ends of vertical or inclined lines by the outer guide lines, and place the edges of the horizontal lines a trifle inside of them in order to make the apparent depths uniform. Further, since the intermediate light lines of the Roman capitals are here replaced by lines of the same weight as those used for the stems, the interior space of the O is relatively increased as compared with H, E, B, etc.

For these reasons the width of the O will be reduced to $5\frac{1}{2}$, and the arcs of circles will be united by short vertical curves of longer radii on the sides. The same construction applies to Q, C, G and D. The width of D is modified so as to keep it intermediate between H and O. As the spur of C disappears the upper and lower parts will become alike.

The curves of B, J, P, R and U may be made semi-circular. Two arcs of circles are also used in &. The curved hair-line projections at the bottom of R and & having nothing to take their place in the Gothic form, the widths are thereby reduced by one-half unit. The right lower stem of R will give the best appearance to the letter when it is straight. The same relative appearance of the upper and lower portions of S and Z is secured by a difference of $\frac{1}{4}$ unit in width as in the Roman form by a difference of $\frac{1}{2}$ unit. Special care should be exercised to have the middle part of the S cross the vertical center line slightly above mid-height.

In inking letters of the size shown on Plate III double lines should be drawn with a narrow space between them, which is filled in afterwards. This enables the draftsman readily to secure uniform thickness of all the parts, and to work more rapidly, as the danger of blotting is thereby reduced to a minimum.

Hair-line Gothic capitals, both vertical and inclined, are shown on Plate V, the latter having a height of 7 units. Special facility should be acquired by the student in the construction of Gothic letters because of their wide range of application, as stated more in detail in Art. 42, using instruments for the larger size and making the smaller sizes free-hand. The inclined letters are especially useful for rapid freehand construction, as slight inequalities in inclination and in other details are not as apparent as in the upright form.

Sometimes the strokes of the heavy letters are made with round ends, but the effect of this detail is not as good as that of square ends.

Four forms of G are shown side by side in Fig. 16 for the purpose of comparison, the lower width being $5\frac{1}{2}$ in all but the last, where it is $5\frac{1}{4}$, or the same as the upper width. Even in this case the letter appears slightly narrower at the top.



Fig. 16.

The third and fourth forms are more completely in harmony with the extreme simplicity of the Gothic style than the first and second. The third presents the better appearance in larger letters constructed with

care, while the fourth is better adapted to small freehand letters. See Plate XIX for an application of the latter.

ART. 10. GOTHIC SMALL.

The Gothic small letters (Plate III) are derived from the Roman by the application of the same principles which were used in the case of the corresponding capitals.

The widths of v, w, x and y are therefore made one-half unit wider than the Roman, and it would perhaps be preferable to make w an additional half unit wider, thus making it the same as m. The resulting width of q is twice the width of v after it is reduced one unit. For the sake of simplicity the o, c and e are constructed with a single circle.

The bulbs of the Roman v, f, j and y are omitted and the curves terminated in very short horizontals, the width of y being reduced one-half unit and of the others one unit. The upper projection of g is treated in the same way.

No substitute is made for the curved hair lines of the Roman a and t. Some draftsmen terminate the vertical stems of the Gothic a and t similarly to the f and j, but this treatment is not in harmony with the simplicity of this style of letter, in which not only the feet but also the spurs of letters are omitted. When the stems are thus extended they re-

place curves which had bulbs in the Roman style and not simply curved hair lines.

The vertical limb of b is sometimes extended down to the guide line, like d, but the form given is to be preferred.

The form of a may be simplified by eliminating the reversed curve in one of its lines, and either extending it on a horizontal to the vertical limb or curving the end downward so that the entire curve may form a part of a single ellipse. The three forms are shown side by side in Fig. 17. A fourth form is given next to these which in small scale free-hand work is frequently employed. The corresponding

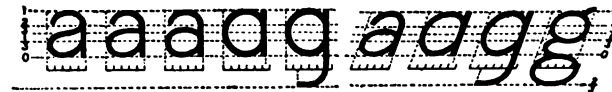


Fig. 17.

form of g is placed on its right. The same letters when inclined are also shown in the figure. The form of g at the end of the line is employed to a limited extent in practice, but is not to be commended on account of its less convenient construction. The forms of both a and g should preferably correspond to their character in stump writing. The lower line of g must be curved to the left in order to distinguish it from q.

All of the inclined letters may be regarded as derived from stump writing rather than directly from the Italic small. The complete alphabets in both the upright and inclined letters in hair line are given on Plate V, the latter having a height of 7 units.

ART. 11. ROMAN OLD STYLE.

The proportions of this style of letter which are given on Plate VI and are 16 millimeters high were obtained by careful measurements of the best printed forms that could be found by the author, those selected being 19.5 millimeters high. Very slight modifications, however, were made in a few cases, as, for instance, in moving the intermediate horizontal lines of P and R from just below mid-height to their present position, which is the same as that of B, and also in widening the lower part of the G to be equal to that of C, their upper parts having been the same. It would, perhaps, be advisable to increase the width of M both above and below by $\frac{1}{4}$ so as to reduce the measurements involving quarter-units to a minimum.

On comparing the H with that on Plate I it will be observed that the distance between the center lines of the stems bears the same relation to the height in both cases. If the exterior width of the old style H be made the same

as the modern or 5 units, the height of the former will be 6.4 units instead of the 6 units of the latter, or if the height be 6 in both cases the widths will be 4.7 and 5 respectively.

The most noticeable difference between the two styles is in the width of stem, the old style being one-seventh of the width and the modern one-fifth, while the light lines of the former are about double the thickness of the hair lines of the latter. The hooks of C, E, F, G, L, S, T and Z have their outer edges inclined instead of vertical. J extends below the lower guide lines, the sides of M are given a slight batter, and the stem of R with its double reversed curvature is replaced by a straight one. The outer edges of C, G, O and Q are circular and the center lines of the curved stems of B, P and R are arcs of circles. The larger part of the interior edge of C is shown as a semi-circle, while another form of the C is shown in the title of the plate. In Q the double reversed curve of the appendage is united to the body of the letter by an easy curve tangent to both. On Plate VII a simple but not so elegant a form is shown, the connecting line being straight and not tangent to the body of the letter but meeting its lower curve at the middle.

If the widths of the letters marked on Plate VI are reduced to the same unit as that used on Plate I the principal differ-

ence will be as follows: B, J, K, P, R and Y are respectively $\frac{3}{8}$, $1\frac{1}{2}$, $\frac{7}{8}$, $\frac{7}{8}$ and $\frac{5}{8}$ narrower; C, G, L, O, Q, T, V, W and Z are respectively $\frac{3}{4}$, $\frac{3}{4}$, $\frac{1}{2}$, $\frac{3}{4}$, $\frac{3}{4}$, $1\frac{1}{4}$, $\frac{3}{8}$, $\frac{5}{8}$ and $\frac{3}{4}$ wider, while the rest are either the same or differ less than $\frac{1}{4}$ from the widths of the modern style. The difference between the upper and lower widths of letters is about 50 per cent. greater except in C and G.

The curves of the serifs are elliptical, and while tangent to the edges of the stems or light lines, make a decided angle with the horizontals. These curves occur on both sides instead of only on the outer side as before, and while being relatively larger in most cases they are smaller in the serifs at the ends of the light lines of A, K, M, N, U, V, W, X and Y.

The lower horizontals are shown on Plate VI to be slightly heavier than the upper ones. While such a distinction in weight produces a pleasing effect on letters drawn to a fairly large scale, it is not practicable on small letters. All other details are indicated on the plate so clearly as not to require any further description.

The small letters differ in such a few particulars from the modern style that they have not been separately constructed. They are shown on Plate XLI, which is printed from type. Aside from the same difference in weight which exists

between the capitals, the main feature which characterizes the style is that in all single caps inclined curves are substituted for the horizontal right lines, and so arranged as to make the stem pointed. The serifs projecting on both sides of the limb to which they are attached remain horizontal, as in the modern style. All bulbs are elongated.

ART. 12. FRENCH OLD STYLE.

On Plate VII are shown the French Old Style capitals in comparison with the Roman Old Style, the former being a variation of the latter, to illustrate more effectively their differences of form. They are reduced to the same height and the letter H was found to have the same width in the three alphabets shown on the plate.

The lower series of French Old Style was copied from Georg Heinrich Paritius, 1710, as published in *Collection D'alphabets Ornés*, by A. LEVY of Paris, while the upper series was constructed after making a careful comparison of a large number of printed types ranging from 16 to $23\frac{1}{2}$ millimeters in height, as found in architectural works issued by a number of the leading modern publishers of Paris. The proportions given represent what might be called the moderate style, as opposed to the extreme style in which B, E, F, L, P, R and S are materially reduced in width, while

the other letters remain about the same. The lower alphabet on the plate belongs to this style in most of its features, and the contrast between such letters as S and O, for example, is very decided and serves to decrease the legibility.

The widths of the letters in the upper series are given in the following table. For instance, the widths of E follow in

WIDTHS OF FRENCH OLD STYLE CAPITALS IN
UPPER SERIES OF PLATE VII.

A	7½	H	7	O	9½	V	7½
B	5½, 6	I	¾	P	5½, ¾	W	7½-4¼+7½
C	8¼, 8½	J	¾, 4	Q	9½ (5)	X	6½, 7½
D	7½	K	6¼, 7¼	R	5½, 3½, 7	Y	7, ¾
E	5, 4¾, 4¾+¾	L	¾, 4¾+¾	S	5, 5½	Z	7¼, 7¼+¾
F	5, 4¾, ¾	M	6¼, 8¼	T	7¼, ¾		
G	8¼, 8½	N	6¼	U	7		

regular order for the upper, middle and lower parts. The scale used in constructing the Roman Old Style was also employed for this series. The stems measure ¾; the ver-

tical and inclined light lines 5-16, and which are sometimes increased to ¾; the intermediate horizontals of E, F and H are ¾; the upper horizontals of E and F, and both horizontals of Z, are 7-16; the lower horizontal of E and those of L and T are ½, while all the remaining horizontals are 5-16 unit wide. Such elaborate distinctions as these are made very seldom and then only in large letters.

The curved stems of B, D, P and R are made to sag as if constructed of plastic material which is yielding to the influence of gravity. The curves of the caps occur only on the outside of the stems, while those at the bases are found on both sides. Many of the letters have the same form as the Roman Old Style, and the distinguishing features of the others are clearly shown on Plate VII and should be carefully observed by the student. The letter having the poorest design in this style is R, which is formed by adding a flying pendant to the P, which appears to put the letter in unstable equilibrium and is in marked contrast with the fine form of the Roman R just above it.

Sometimes the stems of the extreme style are reduced to ¾.

ART. 13. MODIFIED PROPORTIONS.

The modern Roman and the Gothic letters, whose construction was given on Plates I, II and III, all had that rela-

tion between width and height which was designated as the normal one in Art. 2; that is, the height was 6 units for the exterior width of H of 5 units. The Roman and French Old Styles, given on Plates VI and VII, also have the normal proportion, the height being 9 units and the width of the H 7 units. The same unit of measure was employed for the Gothic as for the modern Roman, as the former is constructed with stems varying up to one unit in width, and as the resulting measurements are easily derived from those of the Roman they are readily remembered.

If the same unit of one-fifth of the width of H had been employed for the Roman Old Style, the measurements obtained would have differed from most of those of the modern Roman by quantities that seem entirely arbitrary and could not be remembered so easily as those given on Plate VI (See Art. 11).

Although it may seem at first that a large number of measurements have already been recorded on the plate referred to, it will be found that their use in practice soon fixes them in mind, so that only occasional reference to the plate may be required.

In order to illustrate the effect of changes in the height and in the width of stem, the following values have been employed in constructing the letters on Plates IV, X and

XI: On Plate IV the height is 7 units and the stems $\frac{3}{8}$ unit wide throughout; on Plates X and XI the values used are given in the table below:

PLATE X.					
Height.	Stem.		Height.	Stem.	
6	$\frac{3}{8}$	Elevation.	6	$\frac{3}{8}$	Throttle Lever.
6	$\frac{3}{8}$	Sway Bracing.	6	$1, (\frac{3}{8})$	Palace Car.
6	1	Precise Levels.	PLATE XI.		
7	$\frac{3}{8}$	Suburban Divisions	9	$\frac{3}{8}$	Chamber of Commerce.
6	$\frac{3}{8}$	Distributing Chamber.	9	$\frac{3}{8}$	Ceiling of the North Hall, etc.
7	$\frac{3}{8}$	Magnetic Declination.	7½	$\frac{3}{8}$	Elevation of West Front, etc.
9	1	Jetty Channel.	7	$\frac{3}{8}$	Screened Nook, etc.
6	$1, (\frac{3}{8})$	Monument.	7	$\frac{3}{8}$	Golden Gate, etc.
7	$\frac{3}{8}$	Switch Stand.	6	$\frac{3}{8}$	Detail of Main Fire-place.
6	1	Asphalt Pavement.	8	$\frac{3}{8}$	Cornice and Parapet, etc.
7	$\frac{3}{8}$	Helical Springs.	8	$\frac{3}{8}$	End of Grand Hall, etc.
6	$\frac{3}{8}$	Three-throw Switch.	7	1	The University Library.
7	$\frac{3}{8}$	Direct-coupled Generator.			
7	1	Potsdam Sandstone			

The scales employed were, as a rule, not the same for the different lines containing letters of the same style, but were

selected so as to make the lines consisting of one or more words of approximately given lengths.

It will be noticed that an increase of height from 6 to 7 while the stem remains unchanged reduces the apparent weight slightly, but when the stem is reduced to $\frac{3}{4}$ at the same time, as, for example, in "Suburban Division" and "Helical Springs," on Plate X, the difference between them and the letters just above them is considerably magnified.

In the title, "Detail of Main Fireplace," on plate XI, in which the height is 6, it is observed that the reduction of the stems to $\frac{1}{2}$ has increased the relative widths of interior spaces too much, and thereby marred the general appearance. If, therefore, a very light and airy letter is desired, the height should be increased to at least 7 to counteract the effect of a decided diminution in the weight of the stem. In the second line below it the height was increased to 8, and the result is satisfactory. The spurs in both of these lines were shortened a little to indicate the result, but this is seen to be a departure which is not to be recommended. As the inferior appearance in the former example was mainly in the letters with vertical spurs, E, F, L and T, it should be noticed that this condition is not produced by reducing the stem of the Roman Old Style where the spurs are inclined, as is shown in the first line of the plate.

Increasing the height of letters necessarily changes the curvature of lines of contour and the positions of centers from those shown on the plates giving the construction. In B, for instance, the inner edge of each curved stem was drawn on Plate I as an arc of a circle, but if the height is increased the circle should gradually move outward until it becomes the outer edge of the stem. When the circle becomes the center line of the stem its value on the drawing is

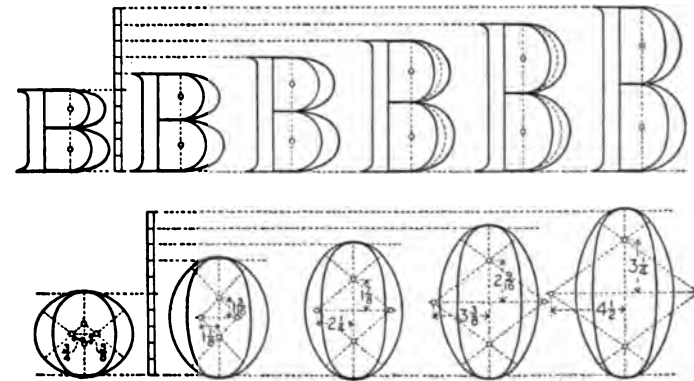


Fig. 18.

to serve only as a convenient guide to the curves of the edges which are drawn freehand. Fig. 18 gives this letter for heights of 5, 6, 7, 8, 9 and 10.

On the same figure the letter O is given for different heights, the outlines being three centered ovals approximating very closely to the ellipse. The centers are located by measurement and the letters may be rapidly constructed in practice by laying off these measurements with the required scale. These centers are also useful in constructing C, G and Q, and when several of them are to be made at one time to the same scale, the most convenient plan is to locate the centers on a piece of tracing paper, on which are also marked the tangents at the sides, so that the tracing may be quickly placed in position and the centers transferred with a needle point. Of course such construction with the aid of the dividers is only needed when the letters are large and better results are required than can be readily secured by a freehand sketch of the outlines. The interior edge is always drawn freehand with its vertical tangents as guides.

The Gothic O should have a curvature about equal to the center line of the Roman form. For a height of 8, if the outer arcs are drawn at the top and bottom with a radius of $2\frac{1}{2}$, the sides can easily be sketched in tangent to these arcs and to the vertical construction lines. For a height of 10 the radius should be $2\frac{3}{8}$. Sometimes the upper and lower parts are made semi-circles, united by vertical straight sides, but this form does not present as pleasing an appearance as if

the sides are slightly curved. The curved portions of B may be semi-circles for all heights usually employed in practice.

The other curved letters, both Roman and Gothic, are treated in a similar manner to B and O, and the remaining letters of the alphabet are constructed with the usual guide lines and the scale in exactly the same way as was indicated in Arts. 4-10, irrespective of their height.

Extended letters are but seldom required, while condensed letters are needed frequently in practice. The use of the former is obviated by reducing the number of lines and using condensed letters if necessary for the increased number of words in any line. The round letters are not so easily constructed when extended as when condensed.

Broad face or full face letters should be sparingly employed in the drafting rooms of engineers and architects. The requisite prominence can usually be secured by using letters of larger dimensions and of the normal weight. Inexperienced draftsmen have a tendency to make the lettering too prominent rather than the opposite. When heavy letters are desired, however, the only change necessary is to mark off the width of stem of $1\frac{1}{4}$ or $1\frac{1}{2}$ units, leaving the outer construction lines unchanged.

Other examples of proportions differing from the normal will be referred to in subsequent articles.

ART. 14. MODIFIED STYLES.

In general it is better for the draftsmen to employ but few styles and to acquire special facility in their construction rather than to attempt to use many styles, most of which have not been thoroughly mastered. While ornamental letters have been excluded from consideration in this volume, and while a few well-selected styles will satisfy nearly if not quite all of the requirements of the drafting-office, it is interesting to observe how the appearance of the Roman and Gothic style alone may be modified by slight changes in details and thus secure a sufficient variety for general use.

Several of these modifications are illustrated on Plates X and XI. One of these consists in making the letters open instead of solid, either shaded or unshaded. The latter style, by its very light weight, allows a larger size to be employed than if the letters were filled in solid. Sometimes the shading is done on the left side for variety, but this is not desirable, as it is contrary to the established conventions in shading drawings of all kinds.

The letters in "Palace Car" are known as the finished Roman, which may also be used in its open form. Those in "Monument" may be regarded as derived from the finished Roman by using the Elzevir serifs. This style is easily

constructed and looks so well that it deserves more frequent use. If all the parts were made of the same weight this style might be considered as a modification of the Gothic, such as is shown in the second line of Plate XI and on Plate XV.

If the serifs and spurs have straight lines substituted for the curves at their sides, so as to give the appearance of a slight enlargement of the stems at those points, the result is shown in the third line of Plate XI, and also in the lower alphabet on Plate XXIII. Plate XXXIX illustrates the effect when the lettering on it is exclusively of this style. This plate is reproduced by the permission of B. H. TICKNOR from the Monograph on Trinity Church, Boston, by C. D. GAMBRILL and H. H. RICHARDSON, published in 1888. By comparing the second and third with the seventh line of Plate XI the difference between these modified styles and the Gothic may be observed.

The results produced by raising the intermediate horizontal lines and of placing prominent serifs on light-line letters are shown on Plate XVIII, which will be described more fully in Art. 46. Some modifications in general form are introduced on Plate XIX.

The influence of all the elements mentioned above on various styles may be studied further by examining Plates XLI-XLVIII, which were printed from type.

ART. 15. LARGE AND SMALL CAPITALS.

The combination of large and small capitals is used to some extent in one-line titles or in sub-titles, and also occasionally in principal titles. This arrangement aids in distinguishing the relative importance of words and also serves to introduce an element of variety into the grouping of letters. This is especially desirable where a title in a single line contains a large number of words. On Plate XI the second line would be improved in appearance by capitalizing the words CEILING, NORTH HALL, and PARTHENON and thereby emphasizing them.

In printing type the small capitals generally have nearly or quite the same height as the short "lower-case" letters, corresponding in size to the large capitals, but on a drawing a better appearance is secured by making them range from three-fourths to four-fifths of the height of the capitals. In the following line

U. S. STANDARD THREAD
U. S. Standard Thread

they have nearly the height of the lower-case letters, which are two-thirds as high as the capitals, while on Plate X, in

the last line but one, in each column, their height is three-fourths of that of the capitals. The difference in height necessarily determines the difference in weight of the stems, since the two classes have the same general proportion, and this difference may become too decided to look well. On Plate XIV is a title containing large capitals and the effect of this feature may be observed by comparing it with similar titles without it.

ART. 16. THE CONSTRUCTION OF NUMERALS.

The guide lines and measurements of the Arabic Numerals of the Modern Roman style are shown in the first line of Plate VIII. The unit is the same as that employed for the Roman capitals on Plate I, and the height is also the same, or six units. The form of the numerals is such that the best appearance is secured by making their average width somewhat less than that of the capital letters. Six of the numerals have the same width of $4\frac{1}{2}$. The width of 4 is the same as 7, if the hair-line projection on its right is excluded, and the same as 0 (zero) if it is included. The upper width of 6 is a little narrower than the lower width of 9, in conformity to the principle stated in Art. 5. The intermediate hair lines of 6 and 9 are slightly above the $\frac{2}{3}$ and $\frac{1}{3}$ guide lines for the same reason. One edge of the bulbs

of 2, 3 and 5 is a little above the same guide lines, but those of 6 and 9 bear a corresponding relation to a $\frac{3}{4}$ and $\frac{1}{4}$ guide line.

Alternate forms of 2 and 7 are given at the ends of the first line, and they are more easily constructed than the others. A corresponding form of the Italic 3 is also shown in the middle of the second line, as well as still another modification of the upper parts of 3 and 7 to correspond to that of 5, and which relieves the appearance of excessive weight in the preceding form. Both edges of the upper stroke are curved. An alternate form of 4 is shown on Plates XXII and XXXII.

The widths of the numerals in the Gothic style are the same as in the Roman, with the exception of 1 and o. If the body was made a unit thick, as is sometimes done, then 1 remains the same. The o would be improved by slightly decreasing the radii of the curves and substituting tangent curves at the sides for the straight lines.

The lower extremities of 3 and 5 do not extend up to the $\frac{2}{3}$ guide line but to about the $\frac{1}{4}$ line, the same as in 9. The fractions $\frac{1}{2}$ and $\frac{3}{4}$ are drawn to such a scale as to make the total height about 50 per cent. greater than that of the integers. Another form of the 3, which is not quite so easily drawn as the one given on this plate, is shown on Plate XVI.

In the Roman Old Style the 6 and 8 are limited by the same extreme guide lines as the capitals. It will be noticed that the height of 1, 2 and o is two-thirds of this, and that the scale employed is exactly the same as that used for the capitals, thus making the guide line marked 1 just a little higher than the corresponding one of the small or lower-case letters. To make this height the same as the small letters would necessitate using another scale and would also make the ascending and descending numerals seem excessively long.

The smaller numerals on the plate are drawn to exactly one-half the scale as the others of the corresponding style whose construction is given.

CHAP. II. THE SPACING OF LETTERS.

ART. 17. THE THEORY OF SPACING.

In the formation of words the letters composing them must not only have the proper relative proportions, as described in the preceding chapter, but must be so disposed that the effect shall be as nearly uniform as practicable. Stated negatively, the letters in one part of a word should not appear crowded as compared with those in another part.

The spacing of letters which fulfils the preceding condition of general uniformity may, however, vary from a fixed standard between the indefinite limits which may be characterized as close or narrow spacing and open or wide spacing. Lines 1, 2 and 3, on Plate IX, show three different spacings for the word Elevation. For most purposes the spacing should not pass beyond these limits.

The proper spacing of letters is equally as important as the good execution of letters having well designed forms. If the process of spacing be improperly carried out, it will destroy the pleasing effect of the most carefully constructed

letters. So far as the author has been able to learn, hardly anything has been written on this subject, and the few paragraphs which he has found fail to outline any definite methods for securing the desired results. The closer the letters are placed the more difficult it becomes to adjust them, and beyond a certain limit the legibility is impaired in the same proportion. If it be necessary to reduce the length of a word without diminishing its prominence, it is better to condense the letters and maintain a medium spacing, as determined by the new scale, rather than to use the normal proportion with a very narrow spacing. On the other hand, if the spacing is wider than that shown in line 3, both the continuity and individuality of the words is impaired, unless there are no adjacent lines. Wide spacing of letters usually implies also the correspondingly wide spacing of words and lines. To lengthen a word without increasing its prominence it is therefore desirable to employ extended letters with a relatively medium spacing. In mapping and in some other

exceptional cases, where names are often considerably lengthened, to show that they apply to given areas or distances, the problem of spacing is much simpler and will be treated in Art. 48.

ART. 18. STANDARD OF REFERENCE.

The space between each pair of letters may be reduced to an equivalent space contained between two parallel stems, and if the relative position of the letters is properly adjusted the corresponding equivalent spaces should theoretically all be equal. Close and open spacing may then be readily compared by means of the corresponding equivalent spaces. As to what constitutes equivalence will be considered later. A vertical stem is taken as the side of the equivalent space, because about one-half of the letters have at least one side composed of such an element.

Since the letter H was used as a standard of reference in determining the widths of other letters it may also be employed in finding a standard for spacing. In Art. 4 the clear distance between the stems of the modern Roman H was fixed at 3 units, but as the stems are connected by a horizontal hair line the apparent effect of the interior space of H is the same as that of the clear space between two unconnected stems somewhat less than 3 units apart. Let this

space be taken as $2\frac{1}{2}$ units. This width will make the interior and exterior spaces limited by the top and bottom guide lines approximately uniform and gives a pleasing appearance to the letters as grouped in words. This spacing of $2\frac{1}{2}$ units, which will be adopted as suitable for general use, is shown in line 2 of Plate IX, while the spacing in line 1 is 2 units, and that in line 3 is 3 units.

For the purpose of making a more extended comparison between the equivalent spaces they will be given for the lettering on Plates X and XI, which includes capitals and small letters of various styles. On Plate X, taking the two columns of subtitles in succession, the equivalent spaces are 3, $2\frac{1}{2}$, 3, $2\frac{1}{2}$, $2\frac{1}{2}$, 3. (4), $2\frac{1}{2}$, $2\frac{1}{2}$, $2\frac{1}{2}$, 3, $2\frac{1}{2}$, $2\frac{1}{2}$, 3, $2\frac{1}{2}$ and 3, and on Plate XI they are (4), 3, 3, —, $3\frac{1}{2}$, 3, 3, 3 and 3.

The proportions of the letters on these plates were given in Art. 13. As the scale used in the Roman Old Style is 5-7 of that of the others the space of 4 for that style equals about 3 in terms of the other scales.

ART. 19. PRINCIPLES OF SPACING.

The apparent effect of Roman letters depends both on their form and on the weight of the parts composing them. Because the serifs are constructed after the main parts are

placed in position, and since their influence on the general appearance of the letter is subsidiary, it is preferable to make the necessary measurements for spacing independent of them, so far as possible.

It seems reasonable that the effect of the masses of white (the color of the paper) between the black letters must be approximately equalized in spacing, and therefore the area of these spaces becomes one prominent element in the theory of spacing. The word "Elevation," in line 5 of Plate IX, is constructed by making the areas between the letters the same throughout. The areas are equal to those of rectangles as high as the letters and 3 units wide, since this average width caused the word to have the same length as that in line 2. The outline of the space between E and V is regarded as extending along horizontal lines from the tips of the upper and lower spurs of E to its central spur, and similarly the spaces adjacent to L and T are considered as limited by horizontal lines drawn from the tips of the spurs to the stems.

As these areas have such different forms it is seen that the adjacent parts of some letters in line 5 are thereby brought so much closer together than others as to produce the appearance of unequal distribution. This indicates that the clear distance between letters is another element which must

be taken into account. Line 6 shows the same word when its letters are arranged for equal clear distances, before their serifs are drawn. The clear distance is two units, and it is found to give the same length to the word as that in line 5.

It is now observed that the spaces between L and E and between E and V in line 6 are apparently too large. Both of these, but especially the former one, seemed to be too small in line 5. By combining the method of equal areas with that of equal distances, giving the same weight to each, a result is obtained which is shown in line 4. A uniform appearance is now approximately secured for the spaces except that between O and the letters adjacent to it. Since O is without projecting serifs, and does not have its greatest width directly opposite to the serifs of the adjacent letters, it needs to be brought a little nearer to them.

Since N has only hair lines on its sides, and appears to be farther from O than I is on its other side, it indicates that the weight of exterior lines is a third factor which enters into spacing. Line 2 shows the effect of making these modifications. The equivalent space in line 4 is the average of those in lines 5 and 6, or $2\frac{1}{2}$ units, and is therefore the same as that in line 2, with which its spacing may be compared directly.

In line 7 there is a group of letters showing the combina-

tion of the vowel A with consonants having their greatest width either at the top or at the middle. In this line they are arranged by equal areas on a basis of an equivalent space 3 units wide, in line 8 by equal clear distances (exclusive of the serifs) on a basis of 2 units, and in line 9 by averaging the areas and distances. It will be observed that the lengths of the three lines are very nearly equal, and this result will in general be obtained by those combinations of letters which occur in practice. The letters in the right half of line 8 appear to be somewhat crowded as compared with the left half, and, as the clear distances have here to be measured obliquely, it is gratifying to notice that the disposition of the letters by equal areas in line 7 seems to be about as uniform as that in line 9.

The combination of the vowel O with consonants whose greatest width is either at the top or bottom is shown in line 11 and a part of line 10, the spacing being due to averaging areas and clear distances. The distances between the vertical construction lines limiting the widths of the letters (as given on Plate I), when spaced by areas and by clear distances, differ by only 1-16 unit in two-thirds of the intervals, while the maximum difference (between O and X) is only 5-16, which is hardly appreciable. This group of letters could therefore also be spaced by means of areas alone.

The combinations LT, LV and LY are spaced by the average of areas and clear distances, and it is seen that the adjacent vertical construction lines on the sides of L and T and of L and Y pass each other, the spaces being $-\frac{1}{2}$ unit. This relation gives the appearance of crowding in a spacing of $2\frac{1}{2}$ units and may be obviated by limiting the minimum space to zero. It is liable to occur in but few combinations. The effect of applying such a rule is shown in the word Altar, in the last line of the plate.

When two such letters as L and A come together, as in "Claims," in the same line, the application of the preceding principles may not allow sufficient room for the addition of the adjacent serif on A. If not, the letters must be moved apart so as to admit the serif which may, if desired, be slightly reduced in size. When F or T comes next to V, W or Y there will be sufficient room for equivalent spaces of $2\frac{1}{2}$ units, but not for those 2 units wide.

ART. 20. METHODS OF SPACING.

To facilitate spacing by equal areas alone, it is necessary to determine the position, on each side of every letter, of a vertical line which shall enclose an area within the extreme horizontal guide lines equal to that of the contour of that side. These lines, which may be called spacing guides, should be

located with reference to the vertical construction lines defining the width of the letters before the serifs are added. Thus for the letter A, the outer construction lines *a* and *d* in Fig. 19 are $5\frac{1}{2}$ units apart, and as the sloping hair line on the left has a horizontal component of $2\frac{1}{2}$ units, the vertical guide *b* enclosing the same area as the hair line is $1\frac{1}{4}$ units from the left-hand construction line *a*, while the guide *c* on the right side is $1\frac{1}{2}$ units from the corresponding construction line *d*. In the cases of C and G it is assumed that an interior square whose side is the clear opening of the letter belongs to the adjacent exterior space. In E, F, J, L, R, S, T and Z horizontals are drawn from the points of the projecting spurs or curves of the letters to the stems, except in the cases of E and F, where they meet the middle spurs before reaching the stems, and these horizontals are regarded as a part of the contour line.



Fig. 19.

The relative position of the guides is given in the second and third columns of the following table. In the fourth and fifth columns are given the adjusted values for those letters whose adjacent spaces are sometimes determined without considering the clear distance, the modification being due to the weight of the side of the letter, and, in some cases, to

the absence of serifs projecting beyond the construction lines. For instance, the guides are moved inward on O, as that letter has no projections. This is also shown to be necessary, as it is seen that the spaces in line 11 of Plate IX are all somewhat larger than those in line 7, with the exception of those next to C, which letter has nearly the same form as the O.

The guides crossing the hair lines of A, U, V and W are changed $\frac{1}{8}$, as the hair lines are lighter in weight than the stems, the change being small, since the difference in inclination between the hair lines and stems of A, V and W partly compensates for the difference in weight. As L has no projections on its right side, its guides should be moved about $\frac{1}{4}$ toward the left, but since the side of its spur lies so far beyond the guide, the latter ought, on that account alone, to be moved about $\frac{1}{2}$ toward the right. In the cases of F and T, which do not project so far, these double changes may be regarded as neutralizing each other. The width of 6 units for R is to be decidedly preferred, but if that of $5\frac{1}{2}$ is used, the corresponding distance of the spacing guide is $\frac{3}{4}$, as entered in the table on opposite page in parentheses.

In columns 6 and 7 of the table are given distances which are obtained by taking one-half of those in columns 2 and 3 (which implies taking the mean of areas and clear distances),

ROMAN CAPITALS.	Guides for Equal Areas.		Adjusted Guides for Equal Areas.		Adjusted Guides for the Average of Areas and Distances.		ROMAN CAPITALS.
	Left.	Right.	Left.	Right.	Left.	Right.	
(1) A	(2) $1\frac{1}{4}$	(3) $1\frac{1}{2}$	(4) $1\frac{3}{8}$	(5) $1\frac{1}{2}$	(6) $\frac{3}{4}$	(7) $\frac{3}{4}$	(8) A
B	0	$\frac{11}{16}$		$\frac{7}{8}$	0	$\frac{3}{4}$	B
C	$\frac{9}{16}$	$\frac{3}{4}$	$\frac{3}{4}$	1	$\frac{1}{2}$	$\frac{1}{2}$	C
D	0	$\frac{15}{16}$		$\frac{3}{4}$	0	$\frac{1}{2}$	D
E	0	$1\frac{1}{4}$			0	$\frac{3}{4}$	E
F	0	$\frac{3}{4}$		$1\frac{3}{4}$	0	$\frac{3}{4}$	F
G	$\frac{9}{16}$	0	$\frac{3}{4}$		$\frac{1}{2}$	0	G
H	0	0			0	0	H
I	0	0			0	0	I
J	2	$\frac{1}{2}$	2	$\frac{1}{2}$	$\frac{7}{8}$	0	J
K	0	$1\frac{1}{4}$		$1\frac{1}{4}$	0	$\frac{5}{8}$	K
L	0	$2\frac{1}{4}$		2	0	$\frac{7}{8}$	L
M	0	0			$\frac{1}{4}$	0	M
N	0	0			$\frac{1}{4}$	$\frac{1}{4}$	N
O	$\frac{9}{16}$	$\frac{9}{16}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{1}{2}$	$\frac{1}{2}$	O
P	0	$2\frac{3}{16}$		$\frac{2}{2}$	0	1	P
Q	$\frac{9}{16}$	$\frac{9}{16}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{1}{2}$	$\frac{1}{2}$	Q
R	0	$1\frac{5}{8}$			0	$1\frac{1}{2}$ (or $\frac{3}{2}$)	R
S	$\frac{1}{2}$	$\frac{3}{4}$			$\frac{1}{2}$	$\frac{1}{2}$	S
T	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$\frac{3}{4}$	$\frac{3}{4}$	T
U	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	0	$\frac{1}{4}$	U
V	$1\frac{3}{8}$	$1\frac{3}{8}$	$1\frac{3}{8}$	$1\frac{1}{4}$	$\frac{5}{8}$	$\frac{5}{8}$	V
W	$1\frac{1}{4}$	1	$1\frac{1}{4}$	$1\frac{1}{8}$	$\frac{5}{8}$	$\frac{5}{8}$	W
X	$1\frac{1}{8}$	$1\frac{5}{16}$	$1\frac{1}{8}$	$1\frac{1}{4}$	$\frac{1}{2}$	$\frac{5}{8}$	X
Y	$1\frac{1}{8}$	$1\frac{1}{2}$	$1\frac{1}{8}$	$1\frac{1}{2}$	$\frac{3}{4}$	$\frac{3}{4}$	Y
Z	1	$\frac{3}{4}$	$1\frac{1}{4}$	1	$\frac{3}{4}$	$\frac{3}{4}$	Z

provided the nearest points are directly opposite, and modifying the result by taking into account the effect of difference in weight and of the addition of the projecting parts. For example, the guides on the left of M and on both sides of N are moved inward $\frac{1}{4}$ unit on account of weight. The effect of this change is shown in the spacing of the second N in "Longitudinal" in line 12 of Plate IX, and in the space between I and M in "Claims" in the bottom line. The spacing in "Code" and "Longitudinal" shows that the guides obtained by averaging area and clear distance must be modified by about $\frac{1}{4}$ for the O and for the rounded sides of C, G and D. On comparing the first space in "Code" with that in "Gold," it is apparent that the guides in C should be changed on account of weight. The line in L is shifted $\frac{1}{4}$ in order to avoid reducing the clear space too much, as indicated by a study of the space between L and E in "Elevation" (line 4), L and D in "Gold," and L and O in "Longitudinal." The examples referred to in the modifications made for the columns 4 to 7 inclusive indicate sufficiently the principles which have been applied in determining all of the quantities in these columns.

A variation of one-eighth unit is not readily observed, and in practice the width of the equivalent spaces would not need to be determined closer than to quarter units. All

variations are less noticeable in wide than in narrow spacing.

To distinguish the two sets of spacing guides from each other they are referred to in the headings in the table as guides for equal areas and guides for the average of areas and distances. The values of the adjustments were tested by a considerable number of examples, but it is quite possible that the final values may in some cases be slightly modified as the result of more extended use.

ART. 21. RULES FOR SPACING.

As a result of these observations the following rules for the spacing of modern Roman capitals may be given :

First.—All spaces between the adjacent parts of letters whose greatest projections are at the same height, are determined by subtracting from $2\frac{1}{2}$ units the sum of the corresponding distances in columns 6 and 7 of the table (Art. 20).

Second.—Where the right side of C, E, G, K, S or X, or the left side of Z—whose upper width is but a little less than the lower—is placed opposite to a letter whose widest projection is at the top, the preceding rule is applied, and the resulting space is reduced by one-half the difference between the upper and lower width.

Third.—All spaces between the adjacent parts of letters whose greatest projections are at different heights are de-

termined by subtracting from 3 units the corresponding distances in columns 4 and 5.

Fourth.—If in any case the difference thus obtained is less than zero it shall be increased to zero.

Fifth.—The minimum allowable space must admit the serifs, if any, without quite touching. The serifs may be slightly shortened, if necessary.

Sixth.—If the spacing is to be on a basis differing by not more than $\frac{1}{2}$ unit from an equivalent space of $2\frac{1}{2}$ units, the above rules will still apply after making the corresponding changes in the quantities " $2\frac{1}{2}$ " and "3" in the first and third rules, respectively. In narrower spacing the influence of clear distances would predominate, while in wider spacing that of areas would be the greater.

The application of these rules to the word "Elevation" gives the following result: The first space is $2\frac{1}{2} - \frac{1}{2} = 2$; the second, $2\frac{1}{2} - \frac{7}{8} = 1\frac{5}{8}$; the third, $2\frac{1}{2} - \frac{1}{2} - \frac{5}{8} - \frac{1}{8} = 1\frac{1}{4}$; the fourth, $3 - 1\frac{1}{4} - 1\frac{3}{8} = \frac{3}{8}$; the fifth, $3 - 1\frac{1}{2} - 1\frac{1}{2} = 0$; the sixth, $2\frac{1}{4} - \frac{3}{4} = 1\frac{1}{4}$; the seventh, $2\frac{1}{2} - \frac{1}{2} = 2$, and the eighth, $2\frac{1}{2} - \frac{1}{2} - \frac{1}{4} = 1\frac{3}{4}$. It is seen that this spacing differs but little from that given in line 2 of the plate, and which was done before the above rules were deduced. The value of the rules may be tested by inspecting those plates which were drawn by the author, as indicated in the preface.

ART. 22. SPACING ROMAN SMALL.

As k, o, s, v, w, x and z have the same forms as the corresponding capitals they will be spaced in the same manner. The y will be treated like v, unless it should come after j or g, which occurs so seldom that no general provision for it needs to be made; e is so nearly like the o that it may be spaced like it, and the rounded sides of c, b, d, p and q are also treated like the o. When f precedes i its bulb displaces the dot, and when it precedes l its bulb is omitted and the curved hair line is joined to the cap of the l.

The measurements corresponding to those of columns 6 and 7 in the table in Art. 20 are $\frac{1}{2}$ for the left of a, 1 for the right of a, $\frac{3}{4}$ for the right of c, 1 for the right of r, 1 for the right of t, $-\frac{1}{2}$ for the left of t, but which is used only when it follows r. If the construction lines limiting the lower width of g are used, the measurements are $\frac{3}{4}$ on the left and $\frac{1}{2}$ on the right, the latter being reduced in case the cap of an adjacent letter should come nearer to the bulb than a half unit.

The spacing guides on the right of h, n and m, and on the left of u, are so close to the sides of the letters that the distance may usually be regarded as zero. On large letters the distance may be taken at $\frac{1}{8}$.

The only instances in which the method of adjusted areas would need to be employed is in combinations of e or o with

k, v, w, x, y and z, and that can be avoided by using the measurements in columns 6 and 7 of the table referred to and subtracting an additional half unit.

For examples in spacing this style see Plate X, the equivalent space being 3 for "Precise Levels" and "Potsdam Sandstone," and $2\frac{1}{2}$ for "Suburban Divisions."

When a capital precedes a small letter the space between them is generally made the same as if both were small letters. In the case of overhanging letters the spacing guides for areas will naturally be employed.

ART. 23. SPACING STUMP WRITING.

This style is easily spaced, since nearly one-half of the letters have curved hair lines projecting beyond their bodies on the right. Whenever these hair lines are adjacent to the stem of a letter whose edge coincides with the outer construction line at the $\frac{1}{4}$ guide line, as in h, l, i, t, f, k, b, n, m, u or v, a space of one-half unit may be left between them, and when they are adjacent to curved stems, as in q, g, d, o, c, e and a, the hair lines should end on the left construction line of those letters and thus be approximately distant a half unit from the stem itself. In other words, the spaces between the adjacent construction lines in these two cases are one-half and zero respectively. When other elements of the

letters are adjacent to each other they should be spaced like the Roman small on the basis of an equivalent space of $2\frac{1}{2}$. Where a letter like a is derived from d, instead of the corresponding a in Roman small, it must be treated like d in spacing.

Examples are shown on Plates X and XVII. The equivalent space in "Helical Springs," however, is 3, which is seen to be too wide for the spaces not determined by the projecting hair lines. It is better to make it always $2\frac{1}{2}$, as is done in Title 2 on Plate XVII. In very small letters the hair lines are frequently made to touch the succeeding letters instead of leaving a small space as indicated above. See Plates XXVII and XXIX.

ART. 24. SPACING GOTHIC LETTERS.

The spacing of the Gothic letters is simplified by the absence of serifs and spurs. The measurements should not differ materially from those of the Roman style, and in the interest of convenience may be fixed so as to be applicable to all weights of limbs, ranging from a hair line to one unit in width.

The final test of the measurements given in the following table lies in a careful inspection of the results secured by their use in practice. It is quite likely that some improvements may be made after a more extended application than

the author has been able to make. Several examples are given on Plate X, the equivalent space being 3 for "Elevation" and $2\frac{1}{2}$ for "Sway Bracing," "Switch Stand" and "Throttle Lever." Plate XVI is also a good illustration, the equivalent space being $2\frac{1}{2}$ units throughout.

TABLE FOR SPACING GOTHIC CAPITALS.

	Adjusted Guides of Equal Areas.		Adjusted Guides of the Average of Areas and Distances.			Adjusted Guides of Equal Areas.		Adjusted Guides of the Average of Areas and Distances.	
	Left.	Right.	Left.	Right.		Left.	Right.	Left.	Right.
A	$1\frac{1}{4}$	$1\frac{1}{4}$	$\frac{3}{4}$	$\frac{3}{4}$	N			0	0
B		$\frac{3}{8}$	0	$\frac{1}{4}$	O	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
C	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	P		2	0	1
D		$\frac{1}{2}$	0	$\frac{1}{2}$	Q	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
E			0	$\frac{1}{2}$	R			0	$\frac{1}{2}$
F		$1\frac{3}{4}$	0	1	S			$\frac{3}{8}$	$\frac{3}{8}$
G	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	T	$1\frac{3}{4}$	$1\frac{3}{4}$	1	1
H			0	0	U	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$
I			0	0	V	$1\frac{1}{4}$	$1\frac{1}{4}$	$\frac{3}{4}$	$\frac{3}{4}$
J			1	$\frac{1}{2}$	W	1	1	$\frac{1}{2}$	$\frac{1}{2}$
K		$1\frac{1}{2}$	0	$\frac{3}{4}$	X	$1\frac{1}{2}$	$1\frac{1}{2}$	$\frac{1}{2}$	$\frac{3}{4}$
L		2	0	$1\frac{1}{4}$	Y	$1\frac{3}{4}$	$1\frac{3}{4}$	$\frac{1}{2}$	$\frac{1}{2}$
M			0	0	Z	$1\frac{1}{4}$	$1\frac{1}{4}$	$\frac{1}{2}$	$\frac{1}{2}$

The Gothic small are to be treated in a similar manner to the Roman small, as described in Art. 22, by comparing them with their own capitals. The left spacing guide of a

and the right guide of r are placed in the same positions as for the Roman small. The right guide of g is, however, moved $\frac{1}{4}$ farther to the left, as the upper appendage does not project over so far as the corresponding bulb in the Roman style. Those in s may be changed to $\frac{1}{2}$ instead of $\frac{3}{8}$, as in the corresponding capital, while c is treated like the capital to which it is similar.

In spacing f and t it is more convenient to measure from the stem than to draw construction lines through the ends of the cross bar. The guide lines on both sides are $\frac{1}{2}$ unit from the stem. When f precedes i the dot is not omitted as in the Roman.

Four sub-titles are shown on Plate X, two vertical and two inclined, the equivalent spaces being $2\frac{1}{2}$, 3, $2\frac{1}{2}$ and $2\frac{1}{2}$ respectively. Other examples of spacing Gothic small are given on Plates XVI and XVII.

ART. 25. WORD SPACING.

The equivalent spaces between the words in lines 2 to 6 on the left of Plate X are $7\frac{1}{2}$, 9, 9, 9 and $8\frac{1}{2}$, and those in the lines on the right are 7, 8, $7\frac{1}{2}$, 10, 9, $8\frac{1}{2}$, $7\frac{1}{2}$ and 8 respectively. The corresponding spaces on Plate XIV and in the left half of Plate XVII are 8, while those on Plate XVI are 7 units. A comparison of these spaces leads to the con-

clusion that all of them are of ample width, and several might be reduced somewhat to advantage. For capitals a space of 7 or $7\frac{1}{2}$ units is sufficient, and for small letters it need not be more than a unit wider. For an equivalent space of $2\frac{1}{2}$ between letters an approximate rule might be given to make the space between words about three times that between the letters. Any increase in the latter would make an equal or slightly larger increase in the former.

In measuring these spaces the method of equal areas would doubtless be the more accurate, but as so large a percentage of the spacing is done by averaging areas and clear distances it is more convenient to apply the same method here, and it will be sufficiently close for all practical purposes.

The space between words separated by a comma may be increased about one or one and one-half units, while the space following the end of a sentence should be about double the usual space between words.

In general, words should only be separated far enough to cause them to stand out distinctly for easy recognition in reading. Legibility also requires the distance between the lines to be greater than that between the words in the same line.

ART. 26. TABLE FOR SPACING.

A table for spacing Roman and Gothic letters, arranged like the following, on a single sheet of paper, has been found to be so convenient that it is inserted here. A similar one should be prepared by the student who wishes to use the

Roman or French Old Style. In preparing one for the Hair-line Antique on Plate V the clear distance must be measured, not between the adjacent vertical construction lines, but between the ends of the serifs, since the serifs are as prominent as the limbs.

CHAP. III. TITLES.

ART. 27. MAIN TITLES.

Every separate drawing which is worth making and preserving should have a title as a means of convenient identification while in use and of reference when filed away. Even a rough sketch which may be used only for a few days should have a brief title marked on it if it be but in ordinary script. The draftsman who made a given map or plan may remember it for some time without such an aid, but other persons must often handle it, and in an office where there are many other drawings in constant use it is necessary to have all of them marked so that any one may know what they are.

The amount of labor which is expended in making a title should be proportioned to the cost of the drawing and to the use to which it is to be put. Drawings of an important project which are to be shown to men who are expected to furnish financial means for its execution, if they can be favorably impressed, are usually given more elaborate titles than

those which are made either before or during the progress of construction for the use of the office and the shops, or of the contractor.

Some drawings, like the standard office maps of a large working mine or of a city, are assumed to be in continued use for many years and, therefore, merit more care in their construction, including the titles, than others of a similar type which are provided for merely temporary purposes.

ART. 28. CONTENTS OF THE MAIN TITLE.

The main title of a drawing or sketch of any object should contain all the facts which it is essential for any one to know who will have occasion to study or refer to the same, not only at the time it is made but at any subsequent period.

The first item usually refers to the kind of drawing, specifying whether it is a sketch map, plan, elevation, section or profile; modifying terms being frequently employed in connection with all of these expressions. For instance, a map

may be designated as an index map, a contour map, a topographical map, a hydrographic map or a railroad map; the plan may be a general plan or a detail plan, or of the first, fifth or twenty-third floor of a building; the elevation may be a front, rear or side elevation, an East, West, North or South elevation, or a sectional elevation, while the section or profile may be longitudinal or transverse. If the plan, elevation, section, etc., or any combination of them, are all on the same sheet then these terms are omitted from the general title and placed as sub-titles under the corresponding parts of the drawing.

The second item consists of the name or designation of the object represented, and may include its more prominent part, occupying a single line, together with subordinate terms, which are placed in one or more subsequent lines. This portion of the title should be as specific as possible, but expressed as briefly as may be consistent with this character.

The third item relates to the party for whom the work was done, and may be a private person or firm, a corporation or a government. Sometimes this part of the title precedes the item which was stated above as generally being the first one, examples of this arrangement being shown in the titles on Plates XIV and XLVI.

The fourth item gives the name of the person, firm or department that made the design or executed the work, or had responsible charge of the same. If the work is executed by contract the name of the contractors usually does not appear, unless the drawing refers to a report relating to the progress of the work, and is used in determining the payments of the same. The draftsman's name should appear somewhere on the sheet, but usually not in the title. Whenever the name of a place is not implied in the statement of the data in any of the three preceding items, and is essential as a matter of information, it must be inserted separately.

The fifth item gives the date. The date may refer to the time when the survey was made for the map or when the design was completed or approved, or the period during which the construction was carried on, whose progress and results are shown. The date when the drawing is finished or published is but seldom inserted in the title, but is generally marked elsewhere on the sheet, as will be indicated in Art. 36.

The sixth item states what scale was employed in making the drawing. This should never be omitted in the case of any drawing made by means of a scale or copied from another drawing so constructed.

In many cases another item forms a part of the title, and consists of one or more notes of explanation or reference. If the data in the fifth item would otherwise require too much space, it is transferred to this place where only small letters are used. If subsequent additions or changes are made, references to them with proper dates would naturally be added to these notes.

Titles relating to a variety of subjects are given on Plates XIV–XVIII, XXXI, XXXVI, XLVI and XLVII. The student might profitably make a compilation of the subject matter of a number of titles, test them by the statements made in this article, and determine whether any essential fact was omitted when the purpose is considered for which each of the corresponding drawings was made. The first item may, in the case of a map, for example, be regarded as not essential, since the character of the drawing is supposed to be evident to any one who may consult it.

The historical and legal value of many a map, chart or other drawing has been materially reduced by the lack of sufficient information in its title, and the loss of money thereby involved in single instances would have paid for a large number of good titles. The importance of this subject demands careful attention in deciding what facts are really essential in any case, and therefore to be stated in the title.

ART. 29. ONE-LINE TITLES OR SUB-TITLES.

Frequently a series of plates may have the same general title, while each one in the set has its own special title, which may be arranged in a single line. Sometimes the main title occupies either the whole or a part of the first plate, while the special titles for each sheet occupy a line inside of the lower border. At other times a general heading, consisting of a condensed statement of the subject in the main title, is also placed on each sheet, in which case it occupies a place just outside of the upper border.

The height of the letters in the general heading may range from about $1\frac{3}{4}$ to $2\frac{1}{2}$ per cent. of the smaller dimension of the border and those in the special title may be from two-thirds to seven-eighths of this height. The corresponding average values may be taken at 2 per cent. for the former and three-fourths for the latter ratio. The height of sub-titles located on various parts of the sheet must be less yet, if also in capitals, or they may be put in small letters. These values are given only as a general guide to the student, whose tendency is often to make the titles too large.

On Plate XI are given a few examples of such titles. The equivalent space between the letters should generally be 3 units, but sometimes may be increased to $3\frac{1}{2}$, and, in exceptional cases, to 4 units. The wide spacing aids in re-

ducing the weight. The spacing used on Plate XI was given in Art. 18.

ART. 30. POSITION OF MAIN TITLE.

When consulting a drawing which lies upon the table the most natural place to look for the principal title is at the top of the sheet, preferably at the right or in the middle. If it is intended to hang on the wall every part of its title ought to be legible from the most favorable position at which the observer could conveniently stand on the floor. If the title is necessarily small it should be nearly at the height of the eye when the chart is properly hung. In large maps this test would bring the title into its lower part. For conveniently finding a sheet in a drawer by means of its title it must be placed at the bottom. The filing of drawings will be referred to again in Art. 36.

It is important, however, that the relation of the title to the drawing as a whole should be such as to make a good appearance. Sometimes the form of the drawing is such that the open spaces practically fix its position independent of any other consideration. The principal title should always be inside of the border, but if it may be reduced to a single line and there is no convenient place for it inside, it may

then be placed at the top of the sheet just outside of the border.

Long profiles usually have no border, and when kept in the form of rolls ought to have a title at each end so as to be readily accessible without regard to the direction in which it is rolled up. Where the roll is narrow the titles are placed beyond the ends of the drawing. If, however, the profiles are kept folded in book form one title will answer for each book.

When the drawing consists of several parts whose relation on the sheet is not determined by other considerations, they may be so arranged as to allow the place of the title to satisfy one or more of the preceding conditions.

ART. 31. PROPORTIONING A TITLE.

The form of the available space for the title frequently determines the approximate relation between its height and width. If not, then the contents of the title, when divided into lines, will indicate whether a wide or narrow form (as compared with its height) is preferable.

On Plate XII is given an outline plan of a title which contains seventeen lines besides the group of eighteen lines of references, at the bottom, to the authorities used in preparing

the map. Its subject-matter, divided and numbered to correspond with the lines on the plate, is as follows :

¹Map of | ²The Alluvial Valley | ³of the | ⁴Mississippi River | ⁵from the | ⁶Head of St. Francis Basin | ⁷to the | ⁸Gulf of Mexico | ⁹Showing Lands Subject to Overflow, | ¹⁰Location of Levees and Trans-Alluvial Profiles. | ¹¹Published by the | ¹²Mississippi River Commission | ¹³1887 | ¹⁴Scale=1 : 316,800, or | ¹⁵One Inch=5 Miles | ¹⁶Scale of Miles | ¹⁷Authorities.

The object represented is specified in lines 2 to 10 inclusive, the last two containing statements showing the limitations of the map as well as its prominent features. The well-known name of the Commission given in line 12 implies that the map was made for the United States Government, and the names of those under whose direction and by whom the various surveys, which furnish the necessary data, were made, as well as the names of those connected with the office reduction and mapping, together with the corresponding dates, are all given in the list of authorities at the bottom of the title. Every essential item of information specified in Art. 28 is given in this title.

The area of the rectangles shows approximately the relative importance of the different lines as determined by the draftsman, EDWARD MOLITOR. It is said "approximately," because the weight and spacing of the letters (which are not

shown) are other factors affecting the prominence of the lines. All the letters in the title are open and shaded except those in lines 9, 10 and from 14 to the end, which are solid. It will be noticed that no two successive lines have the same length, and that if a curve were freely drawn through the extremities of the lines, excepting a few of the short ones lying between much longer lines, its form would be a pleasing one.

The measurements marked on the plate are those of the original expressed in millimeters. The border of the map is 9' 11" high and 3' 9" wide, or 3.023 by 1.143 meters. The height of the largest letters (in line 4) is 2½ per cent. of the smaller dimension of the map border. It will be noticed that the distances between the lines are not all equal. The influence of a very short line like 7 is made to separate 6 and 8, not quite 45 per cent. more than the distance between 8 and 9, which are both long lines, while the more prominent lines 2 and 4 are separated less than 25 per cent. more than 1 and 2.

After these preliminary observations of a published title let it now be required to design one for a plate in this book as an illustration, and containing the following statement, which is used by permission of the Engineer Department named :

Map of the City of Washington, showing the Varieties of Street Pavements laid and under contract on Jan. 1, 1895. To accompany the Annual Report of the Engineer Department, District of Columbia.

First, let the contents be separated into lines and their relative prominence determined. As the plate is wider than its height the lines must be made longer than otherwise. "City of Washington" is easily selected as the most prominent line, and will be made longer and higher than any other. "Varieties of Street Pavement" comes next in order, and although it contains 60 per cent. more letters, the line should be a little shorter and not so high as "City of Washington." "Laid and under contract on Jan. 1, 1895," will look best if all in one line and having still more letters than the preceding one, as well as for the sake of variety, is preferably put in small or lower-case letters. "Engineer Department" and "District of Columbia" should both be prominent, although less so than "Varieties of Street Pavement," and if placed in one line will make it too long to give a good form to the title as a whole. Again, the most prominent line should not be too near the top, and both of these conditions may be avoided by placing "District of Columbia" at the top of the title and "Engineer Department" in

a line by itself. "To accompany the Annual Report" ought to be a little shorter than "Engineer Department," if it can be done without making the letters too diminutive. Small letters are the best for this line also, and should be considerably less in size than those in the line preceding it. As the number of lines must be kept down, "Map of the" will be put in one line, and having but few letters, will be considerably shorter than "District of Columbia." To secure more prominence, it may be given slightly higher letters. Since "Showing the" lies between the most important lines and forms a subordinate part of the principal subject, it will be better to put it in capitals than small letters. The arrangement of lines and of capitals and small letters is shown on Plate XIV.

As an aid in considering these points the title was written in script and disposed in lines which were later modified as indicated above. At the same time a sketch was made on a sheet of common flat paper like the plan on Plate XII by beginning at the top and estimating the size and spacing of the rectangles by eye. It was found that the height was a little too large and that either the height of letters in the spacing of lines or both must be somewhat reduced.

If the form of the area for the title were square the same division into lines would answer, provided the letters were

relatively more condensed and the lines spaced a little farther apart. If on the other hand the area were high and narrow, like that of the title on Plate XII, it would necessitate a new division of lines, perhaps as follows:

DISTRICT OF COLUMBIA.
MAP OF
THE CITY OF
WASHINGTON
showing
THE VARIETIES OF
STREET PAVEMENTS
Laid and under contract on
Jan. 1, 1895.
To accompany
the Annual Report of the
ENGINEER DEPARTMENT.
Scale of feet.

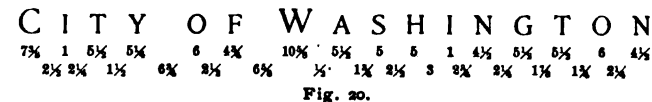
In this form most of the letters would have the normal proportion, while a few of them would probably be extended. The comparative lengths of lines will not be discussed for this form of title and no attempt was made to show any relative difference in the above copy by spacing the type.

A small title with sturdy letters usually looks better than

a larger one with letters approaching the hair-line type. While on one hand a title should not by its prominence overshadow the drawing itself, it is necessary to avoid the other extreme of making the title so small as to require searching for it. The latter condition is liable to occur in a large drawing of details where the plate is rather crowded with lines, letters and figures, and the open space left for the title is rather small.

ART. 32. DETERMINING THE LETTERING SCALES.

In order to complete the proportioning of the title which was begun in the preceding article and to lay out the plan to scale, it is necessary to determine the scale to be used in locating the letters in every one of the lines. Let the scale be obtained for line 3 of the title (Plate XIV). The letters are written on a slip of paper as shown in Fig. 20. Their widths are marked beneath the letters



and below the spaces between these numbers are placed the distances between the adjacent construction lines of the letters obtained by means of the table in Art. 26. As the

capitals C and W are one-third higher than the other letters their measurements are increased in the same ratio, thus reducing all the letters to the same scale. The equivalent spaces are 3 for the letters and 8 for the words. The former is adopted instead of $2\frac{1}{2}$ to aid in extending the length of the line. The space between W and A was modified $\frac{1}{2}$ unit, since W extends some distance above the upper guide line of A. Adding these quantities their sum is found to be $12\frac{3}{4}$. It is now required to find the length of 10 units, as this is a good length for a scale. This can be done conveniently with the aid of the diagram on Plate XIII. A strip of paper is taken and the length of the line as given by the sketch (not shown), referred to in the last article, marked on it. As the diagram on the left of the plate extends only to 60 units, the above quantity may be divided by three and when the strip is in position with the left end on the zero line and the right at $41\frac{1}{4}$ the length of 3 units is marked off. This length represents $3 \times 3 = 9$ units of the required scale, and by using the diagram on the right of the plate all the divisions of the scale may be marked with a well-pointed pencil.

A draftsman can make his own diagram of much larger size and number of divisions on a sheet of cardboard to be kept in a convenient position for reference. The form of an isosceles triangle would be better than the one given on

the plate, which was accommodated to the available space.

With this scale the height of the letter can be marked as a full number of units. It was found that 6 units gave a height which was nearly equal to that on the sketch, and was adopted.

In the same manner the scales are found and the heights, expressed in units, marked on the sketch. If it is found that the heights show more variation than is desirable, they are modified and after this is done the plan can be drawn to scale on the plate with each line in its final position. The heights of the letters in the various lines (Plate XIV) are 7, 7, 6, 6, 7, 7, 7, 6, 7 and 6, respectively. At first a few were marked 8, but were changed afterward.

Sometimes slight changes in length may be secured by changing the equivalent space, remembering, however, that a wide space does not look well when used with letters that are considerably condensed. As a rule the only equivalent spaces to be employed in principal titles are either $2\frac{1}{2}$ or 3 units, or both. The spaces used in this title are 3 except in the first and fifth lines, where they were reduced to $2\frac{1}{2}$ units.

The stems are one unit wide except in "City of Washington," where the width is $\frac{3}{8}$ of a unit.

The length of a line expressed in the units of its scale may be very closely approximated in the following manner for

capital letters: Count all the letters, and to the number add $\frac{1}{2}$ for each W and subtract $\frac{1}{2}$ for each I; add $\frac{1}{3}$ for every large capital (when used in connection with small capitals) and $\frac{3}{4}$ for each space between words, and multiply the sum by the equivalent space when increased by 4. Applying this rule to the same line as before (Fig. 20) its length is found to be

$$[16 + \frac{1}{2} - (2 \times \frac{1}{2}) + (\frac{1}{3} \times 2 \frac{1}{2}) + (2 \times \frac{3}{4})] \times (3 + 4) = 124.8$$

This rule has been applied to a large number of examples, and the difference is very rarely as large as five or six units. If the number of letters in a line is small and the scale large, it is best to use the method first given when the length is also fixed, but in most cases the approximate method is sufficiently close.

For small letters, either Roman or Gothic, the same method may be applied, counting m and w as $1\frac{1}{2}$, and i and l as $\frac{1}{2}$, adding $\frac{1}{2}$ for each capital and 1 for spaces between words. If the same multiplier is used as for capitals, the result varies a little more from the actual measurement in some cases, and usually falls below. The difference, however, rarely exceeds five per cent. in lines of reasonable length.

Let the student compute the lengths of the other lines on

Plate XIV, as well as some on other plates, and satisfy himself as to its utility.

When small letters are employed, reduce the width of the capital at the beginning of any word to the scale of the small letters by multiplying it by $10 \div 6$, and remember the statement in Art. 22 to make the space between the capital and small letter the same as if both letters were small.

ART. 33. THE CONSTRUCTION COMPLETED.

The next step is to take each line of the title in regular order, and, by means of its scale, to lay off the measurements, like those in Fig. 20, on the upper edge of a strip of paper, which is then placed with this edge adjacent to the lower side of the rectangle that the line is to occupy, and properly centered. The straight edge being placed upon the lower part of the paper strip to hold it in position, the construction lines of the letters are readily drawn in the rectangle by means of a small triangle. Line 4 of Plate XII shows the construction lines for the letters in "Mississippi River" in position, and the scale is shown on the left directly below the edge. As a guard against mistakes in laying off the measurements, it is well to write the letters under the corresponding positions as each word is completed.

The center of a line consisting of one or more words is not generally midway between the outer construction lines of the extreme letters, but midway between their outer spacing guides.

The necessary intermediate guide lines are then drawn and the letters completed in pencil in the usual way.

The middle diagram on Plate XIII is convenient in locating any two of the four principal guide lines for the small letters when the other two are given. When the scale is quite small only these four lines need to be used.

It may appear as if the method of construction which has been outlined in this chapter would require more time than the customary plan of sketching the letters in pencil and erasing and shifting them until a satisfactory result is secured. This, however, is not the case, but after the draftsman has thoroughly fixed the method in mind by several applications in practice he can save considerable time over that which would be needed by the usual plan to secure even approximately as good a result. It is possible by this method to construct the entire title in pencil without the erasure or change in position of a single letter, as indeed was the case in nearly all of the titles prepared for this text-book.

ART. 34. EXAMPLES OF TITLES.

From the preceding description of the design of a title, it is observed that a number of conditions have to be met and harmonized in order to secure an excellent effect. Not only must the individual letters be well proportioned and spaced, but the lines of the title must be carefully dimensioned, and spaced both with reference to their own contents as well as their relation to the adjacent lines and to the form of the title as a whole. If the title contains a small amount of matter and the available space for it is comparatively large, the lines and letters may be given a wider or more open spacing than when the conditions are reversed. Another important element affecting the appearance is the style of letter employed. As the influence of these several elements can best be studied from illustrations, a number of examples besides the one already given are inserted in the work and shown on Plates XV-XVIII, XXXI, XXXVI, XLVI and XLVII.

Plate XV contains a title taken by permission from a map whose border measures 5' 8" high by 4' 5" wide, which, together with another map of the same size on "Drainage" and a portfolio of plates exhibiting preliminary construction plans and details, was prepared to accompany a report on the

Sewerage of Ithaca, N. Y. These drawings were executed in commendable style and the lettering throughout was in harmony with the character of the other work. In redrawing the general form and style of the title, the dimensions and spacing of the lines were practically unchanged, but the letters were proportioned and spaced in accordance with the principles given in Chapters I and II. The height of the letters in the upper part of the title are 6, 6, 7, 7, 7, 7, 6 and 6; in the middle 6, 7, 7, 6, 6 and 7; and the word "Explanations" also 7 units. The equivalent spaces are $2\frac{1}{2}$ units except in the line "City of Ithaca," where they are 3 units wide. No large capitals are used in the upper part, but in three of the lines the letters in the connecting words are two-thirds as high as those in the remaining more prominent terms. The title as here published is one-third of the scale of the original. Other features are apparent without further explanation.

The title on Plate XVI is taken from the detail drawing of the design of a connecting rod whose border is about 25 by 39 inches, and which was kindly furnished by Mr. Leavitt for this purpose. The title was treated in about the same manner as the preceding one, that is, the general style and arrangements are substantially the same as on the original, but the letters were constructed and spaced in accordance with the methods given in Arts. 9 and 24. It thus serves the

double purpose of indicating the style of title which is considered as especially appropriate for drawings of a similar character to that from which this is taken and as a more extensive illustration of the effect of constructing, spacing and grouping Gothic letters than was furnished in preceding plates. The title is the same size as the original. The following lines have a height of 6 units: "Cambridge Water Works," "Cylinders, etc.," Scale and Date, E. D. LEAVITT, Mechanical Engineer, and 3294. The rest have a height of 7 units. The stems are mainly $\frac{1}{2}$, but a few are $\frac{3}{4}$, as in "Connecting Rod," while the equivalent spaces are $2\frac{1}{2}$ units throughout.

The attention of the student is called to the fact that only a single style of letter is used in each of the titles on Plates XIV and XVI, and by comparing them with each other the individuality of each style may be observed. By comparing them with titles, which may be found in any considerable collection of drawings or of some books on lettering, in which a number of styles (sometimes equal to the number of lines) are combined in a single title, it may be apparent how much of the general effect is due to the elements of simplicity and unity.

Title No. 1 on Plate XVII is designed to show the appearance when Roman small letters are used exclusively,

and No. 2 of one in which stump writing is employed throughout. In the former the heights of letters are 7, 6, 6, 6, 7 and 7 and in the latter 7, 6, 6, 6 and 7. In the former the equivalent spaces are all $2\frac{1}{2}$ units wide and in the latter the spacing conforms to that recommended in Art. 23. Both of these titles of diagrams accompanied reports and therefore do not contain all the items usually found in a principal title.

Titles Nos. 3 and 4 on the same plate were constructed to illustrate the use of the inclined and upright Gothic letters drawn free-hand, after the outer construction lines for the letters of the principal lines were located as explained in Art. 32. "Allegheny Valley Railroad" is 9 units, "Illinois Central R. R. Depot, etc.," is $8\frac{1}{2}$ units and "Diagram" is 5 units high, the remaining lines being 6 and 7 units in height. The originals of these titles were used on regular working drawings. These plates serve also to indicate the difference between the general effect of upright and inclined letters. The slope of the letters in No. 2 is a base of 3, while that in No. 3 is a base of $2\frac{1}{4}$ to a height of 8 units.

On Plate XVIII are shown several titles and parts of titles for architectural drawings. The styles of letters employed will be described more fully in Art. 46. It will be noticed, however, that most of the letters are of the "high-waisted"

type and all of them were drawn free-hand after the horizontal guide lines and the vertical spacing guides in pencil were located. In the second title, on the left of the plate, the heights of the letters are 10, 9, 8, 8, 9, 6 and 7, respectively, a variety of heights that would not be allowable in some styles of letters.

If, on account of lack of space, or for any other reason, it is decided to use small letters in the principal line of a title, then they should be employed throughout.

Plate XXVIII contains an admirable title, taken from a chart prepared at one of the offices of the United States Engineer Corps. Although the title is a little too large to look well within the narrow limits of the plates adopted for this book, it was decided to reproduce it the same size as in the published chart. It affords an excellent study in proportioning a title, and was made by the same draftsman who designed Plate XXIV and whose plan of a title was given on Plate XII. The letters are formed with great care and the small letters are round and open in shape, thus giving them a high degree of legibility. The letters in "Lake Superior" have a height of $6\frac{1}{2}$ units and stems 0.8 unit in width.

It would seem as if it were desirable to adopt some standard lettering for all the published charts of the Corps

of Engineers, as in the other departments mentioned in Arts. 43 and 44. At present the annual report of the Chief of Engineers shows, perhaps, a greater variety of styles on its plates than any other similar publication.

ART. 35. EXPLANATORY NOTES.

Notes of explanation, of reference to authorities, or relating to conventional signs, are needed on many drawings and especially on maps. Frequently such memoranda form the lower part of the title, but sometimes additional notes, which relate only to certain parts of the drawing, are placed adjacent to them. The addition of minor explanations in connection with the drawing of some details not only puts them in the most serviceable position, but obviates the necessity for incorporating the same in the specifications.

The title on Plate XV has some notes of explanation, and that on Plate XXXVI gives a list of the authorities used in preparing the map. On Plate XIX are given a number of notes, most of which relate to details. The first two in the second column are taken from the same drawing of a design as the title on Plate XVI.

Plate XIX gives a variety of styles of letters which are suitable for this purpose, but it is important to remember that the style selected should always harmonize with that of

the letters employed in the title and sub-titles, and, at the same time, be appropriate to the subject represented and the general character of the drawing.

Stump writing is most generally employed for notes in titles containing Roman letters. Roman small would be preferable, but their construction requires so much more labor as rarely to justify their use. The style employed in the fifth note of the second column is similar to the Roman small, but as its strokes are of uniform thickness it is more easily and quickly constructed. The inclined Gothic small letters permit a more rapid execution than any other style and are especially appropriate for engineers' working drawings. Slight differences of inclination are not apparent. With some practice the corresponding upright letters, which have a more dignified appearance, can be made with nearly the same facility. As the scale is so small, all the lettering in notes must be done free-hand. The legibility of such memoranda is of the utmost importance, and, therefore, only slight modifications of form are allowable for the sake of artistic display.

By inspecting this plate some minor modifications in the styles of several letters will be noticed, which are introduced either for the sake of variety or for facilitating construction. Special attention is called to the last line on the plate.

Additional notes printed from type are given on Plate XLVIII to show their comparative appearance when different styles of type are employed.

ART. 36.—AUXILIARIES TO TITLES.

Drawings should usually contain the following information in addition to the regular titles: the name of the draftsman, the date of completion, the number of the plate, if there are more than one belonging to the same project, and a reference or index number.

It is frequently of considerable importance to know who executed the drawing, but in addition to the information conveyed to others by the name of the draftsman, it is to him an incentive to the exercise of increased care and skill, and intensifies his recognition of responsibility. In well organized offices, where many detail drawings of designs are made, it is customary to record on each sheet the name, or its initials, of the one who checked the dimensions and other details shown on the drawing, as well as that of the draftsman. A convenient place for the name is on the inside of the lower right-hand corner of the border, and it should always be drawn to a very small scale, say about the size of the explanatory notes in the title.

The date of the completion of the drawing may be placed

in the corresponding position at the lower left-hand corner.

Long established usage has put the number of the plate or chart on the outside of the upper right-hand corner of the border. Sometimes the number of a sheet is made a part of the title, but it is questionable whether this is as convenient, since titles cannot generally be placed in the same relative position. If, as frequently occurs with student drawings, the plates relating to any given course have their own separate titles, which are not necessarily related to each other as the special and general titles referred to in Art. 29, the subject of the course may be appropriately placed near the upper left-hand corner of the border and adjacent to it on the upper side. The size of the letters employed depends on the size of the plate and the relative width of the margin outside of the border.

When the drawings in an office are indexed by means of cards or some other form of index, each drawing is given a number denoting its location in the filing cases, and this is placed as a reference number on the card containing its title, together with any other description which may be considered necessary. This index number may be placed inside of the border at its lower left-hand corner, near the date which is already located there. The date is naturally in very small letters and numerals, while the index number is

much more prominent. The number 3294 on Plate XVI was that of the drawing whose title is there given. The letters H. M. G. within the C directly above this number, give the initials of the draftsman who checked the tracing, and a similar record occurs also on the original drawing.

Different standards relating to these minor and yet important details of a drawing are adopted in different offices, but their treatment as given above is that which in the main accords with the best practice.

On Plate XXXIV are shown the data placed at the corners of the charts of the U. S. Geological Survey, since these have no place for a title, and it is necessary that the name of the Survey and of the authorities and the date should be given briefly and grouped in convenient form. The sheets are named instead of numbered, as sheets are issued simultaneously for different sections of the country, while those for adjoining territory are often published some years apart.

ART. 37. SCALES.

As stated in Art. 28, the scale which is used in construction should always be mentioned on the drawing. A portion of the scale is preferably drawn on the sheet in addition to the usual statement of the relation which its graphical representation bears to the object. This is usually done

in all carefully finished drawings. It is a convenience to be able to use the dividers in connection with it in finding distances or lengths when the draftsman's scale may not be available.

When a drawing is to be used also for reproduction by any of the usual photo-mechanical processes, only the drawing of the scale should be placed on it if, as is usually the case, the reproduction is to be of a different size from the original; or, the desired ratio of the scale of the reproduction may be marked on a separate piece of paper and temporarily attached to the sheet while it is being photographed.

A number of scales of different sizes and styles are shown on Plate XX. Sometimes as many as three scales are drawn on a single chart, as, for example, the scales of feet, of meters and of statute miles. Three scales are shown on Plate XXXI. Scales of feet and meters, or of miles and kilometers, should be more frequently associated than is now customary. Another of the examples given is for a sheet containing both the general plan and details, each having its own scale. Sometimes a plan and sections of different scales may be on the same sheet. In the case of a profile constructed without the use of profile paper, it is necessary to state both the vertical and horizontal scales. There may

be scales of moments, of shears, and of lengths, all on the same sheet. The unit employed in each case should always be clearly stated. The large scale near the middle of the plate is of a kind which is placed on the sheet in order that it may expand and contract with the paper under the influence of atmospheric changes while the map is being plotted.

Working drawings generally contain only the statement of the scale, as all the essential measurements are plainly marked on them, and as the necessary scales are supposed to be at hand if others of minor consequence are desired by the workmen.

The style of lettering used for these purposes should naturally be in harmony with that on the remainder of the drawing. Practice is, however, not uniform in regard to the order in which the terms should be given, that is, whether it is better to use "8 feet to an inch," or " $\frac{3}{8}$ inch to the foot." It would seem to be a good rule always to state first the number which appears on the draftsman's scale. When the engineer's scale is employed, which contains those marked 10 to 60 or 20 to 80, it would be more convenient to say "400 feet to an inch" than "One inch to 400 feet"; while with the scales graduated in units of $\frac{1}{8}$, $\frac{3}{16}$, $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$, 2, 3, 4 inches, the statement would be

"3 inches to the foot," rather than "One foot to 3 inches." Other scales and their lettering may be seen by referring to the plates which contain titles.

The lowest scale on Plate XX was prepared for use in measuring the height of letters when expressed in decimillimeters.

ART. 38. MERIDIANS.

As meridians, or north points, are usually treated in connection with lettering, several examples suitable for maps of different grades of finish are given on Plate XXI. The one in the center is the latest form adopted by the U. S. Coast and Geodetic Survey, and gives both the variation of the magnetic meridian and its annual change. Surveyors might readily supplement the record of the declination of the needle, as obtained by observation, with that of the annual change, by consulting the Isogonic Chart of the United States, published by the Coast Survey, if they do not possess the information from regular observations made for this purpose in the immediate vicinity.

The larger meridian at the right is slightly modified from a form which is more than a century old. The full arrow or ornamental head is always placed on the true north and south line, while the half arrow or head is placed on the magnetic meridian. Ornamentation on meridians may easily

become excessive. Their character should conform to the general style of the lettering.

ART. 39. BORDERS.

The border on engineering and architectural drawings should usually be plain and simple. A single line, not too heavy, may answer the purpose. A better appearance is secured by placing a light line on either side of a heavy one, or in a large map by putting a light line on both sides of it. Topographic charts, on which the latitude and longitude are marked on the border, have one or more light lines placed some distance inside of the others. The borders on Plate XXII were copied from the standards of the U. S. Coast and Geodetic Survey, the scales of the maps to which they are respectively applied being indicated. On Patent Office drawings the border is required to consist of a single line precisely one inch from the edge of the sheet, which is to measure ex-

actly 10 by 15 inches. As a border adds so much to the finish of a drawing it is surprising why it is so often omitted. The time required to place a single line border on a sheet is very small and improves the appearance of even the poorest quality of a working drawing.

The margin outside of the border should be proportioned to the size of the sheet, the finer classes of drawings having the more liberal margins. The increasing tendency to reduce all the drawings made in an office to a limited number of standard sizes is to be highly commended for various reasons.

Occasionally a drawing on a sheet of limited size may have such a form that in order to preserve an adequate margin it is necessary to break the border. Several plates in this book show such an arrangement. This plan, when adopted, is regarded as less objectionable than to reduce the scale.

CHAP. IV. THE SELECTION OF STYLES.

ART. 40. THE ROMAN.

This style is certainly the handsomest and most dignified which can be used on any engineering drawings, but as the style of the letters should be in harmony with the character of the drawing it is limited in its application to those which belong to a higher grade in execution than what are called working drawings. In general the cost of constructing the letters is expected to be less than that of the graphical representation to which they apply, but sometimes the lettering is necessarily the larger part of the drawing.

While no specific rules can be given for selecting the styles of lettering, it may aid the student, or young draftsman who is without much experience in this respect, to indicate some of the leading classes of drawings to which they are appropriate. Those in which the Roman form is properly used are the following: First, the class which includes the various topographic, hydrographic and other maps made by the engineering departments of the National

or State governments; second, the principal maps only of cities and towns, since most of the small maps prepared in a city engineer's office are rather classed with working drawings in this respect; third, fine topographical maps of any description or size, whether made for public or private corporations; fourth, parts of the plans of important projects, like river and harbor improvements, water supply, sewerage, fortifications, etc.

All that is stated above in reference to the Roman applies both to the modern and old styles. The latter is more artistic and is therefore regarded as especially appropriate to architectural drawings where the artistic element prevails. Roman Old Style deserves also more frequent use on fine engineering drawings than is now the practice.

These letters are a portion of the heritage received from the Romans, and the extensive use of the capitals in inscriptions not merely influenced the design but served to perpetuate their form with but very little modification to the present

time. Not only are they especially appropriate for inscriptions on a large scale on monumental structures, but also for the smaller ones on tablets of metal as well as stone. An illustration of the use of "French Old Style" Roman capitals, on a metal tablet, is given on Plate XL, which is inserted through the kindness of the Yale and Towne Manufacturing Company, from whose descriptive pamphlet on Yale Stylo-Chiselry it is taken. The attention of the student is called to the fact that all punctuation is omitted in the design. Some of the titles given on preceding plates were likewise designed without any punctuation. The arrangement of the title answers, in a large measure, the same purpose as the punctuation, and there will usually be no danger of misapprehension due to its entire omission.

On modern architectural drawings V is often substituted for U, and I for J, in imitation of lettering made before that period of the middle ages when U and J were developed as additional letters by modifying V and I respectively. Such a practice, at present, diminishes the legibility and may be regarded as an affectation.

ART. 41. STUMP WRITING.

This style is frequently employed in place of the Roman small for the lettering of the details of plans, profiles and

sections, and on which titles and sub-titles are in Roman, because it is more easily constructed in free-hand when the scale is small. On city maps the names of streets are sometimes put in this style instead of Roman capitals. Its use for notes of reference or explanation has already been alluded to in Art. 35 and is illustrated on Plates XV, XIX, XXVII-XXXI and XLVIII. A title containing this style exclusively is shown on Plate XVII.

ART. 42. THE GOTHIC.

This is the most useful style for any engineer, whatever may be his specialty. It can be used, together with the Roman, on many of the finest drawings of finished structures or of new projects or designs. It is especially appropriate to the great mass of working drawings in various degrees of finish, from the roughest sketch to the careful design completely dimensioned, including plans, elevations, sections and profiles; to preliminary and progress maps and reports in the form of diagrams; to shop drawings of structural work of all kinds, whether of buildings, machinery or any other structures. No lettering is so well adapted for the streets of cities and towns as the Gothic capitals, using the upright form in all cases except for the cheapest outline maps, where the streets are a subordinate feature.

Where the lettering must be very small and the letters are confined between the street lines greater legibility is secured by using the small letters instead of the capitals, the height of the short letters being increased to 70 or 75 per cent. of that of the capitals.

The great number of plates issued annually to accompany the reports of various municipal officers, the bureaus or departments of the State and National governments, the transactions of engineering societies, as well as the advertising hand-books and catalogues of manufacturing establishments, might be materially improved if this style of letters were more uniformly employed, to the exclusion of various types of "fancy letters." The 63 plates in the Washington Bridge, by W. R. HUTTON, are a good illustration of the use of the upright and inclined Gothic capitals throughout. The general appearance of neatness in these plates is largely due to the style of the letters, which are open in shape and legible. These letters are called block letters on the sheet of standard lettering of the U. S. Coast and Geodetic Survey (see Plate XXIX), where they are used in words and names connected with navigation. The style more generally known as block letters may be seen in the first line of Fig. 21 in Art. 47.

Its legibility and rapid free-hand construction render it also appropriate to sheets containing tables of various kinds,

which are to be reproduced by blue printing for office use.

ART. 43. STANDARDS OF THE U. S. COAST AND GEODETIC SURVEY.

The standard lettering of the United States Coast and Geodetic Survey is given on Plates XXVI to XXIX inclusive, and the student should carefully study the rules and explanations which accompany the letters. It will be noticed that but few styles are adopted, the Roman and Italic being the principal ones, while the Gothic (designated "block" on Plate XXIX) is more limited in its use. The stump writing is substituted for the Italic small.

The distinction which is made in using upright letters in names and words connected with land, and inclined letters in those connected with water, should be more generally observed by city engineers and by those in private practice than is now the custom.

On comparing the Roman capitals with those on Plate I it is found that the widths of most of the letters are the same, and that the corresponding height is $6\frac{1}{2}$ units, while the stem is just a little over a unit wide.

Plate XXX affords an interesting study of the comparative appearance of different characters when reduced to the same height. The italics have a steeper slope than those on the

other plates and their relative appearance should be observed. At the right of the plate are shown the words "channel" and "light house," of the heights of 15, 12 and 10 decimillimeters, when engraved in three thicknesses of limbs of $\frac{1}{6}$, $\frac{1}{8}$, and $\frac{1}{10}$ of the height respectively. The differences in weight are of course not so apparent on lithographs as on sheets printed directly from the engraved copper plates.

Plate XXXI gives a specimen title, and Plate XXXII is a map of the vicinity of Coney Island, or of the entrance to New York harbor, taken from chart No. 120, whose scale is 1:80,000. This map shows the application of all the styles of lettering employed by the Survey, and gives them for islands, towns, points, beaches, villages, soundings, quarantine, bays, inlets, creeks, bars, shoals, character of ocean bottom, lights, channels, buoys, and life saving stations.

Plates XXVI-XXXII are inserted in this work by the kind permission of the Superintendent of the U. S. Coast and Geodetic Survey and were printed from stone by means of lithographic transfers taken from the engraved plates.

ART. 44. STANDARDS OF THE U. S. GEOLOGICAL SURVEY.

Plate XXXIII contains the classification of the lettering adopted by the United States Geological Survey for its maps.

The heights of the letters given vary from 60 to 5 decimillimeters, but when applied are varied according to the relative importance of the features and the size of the chart.

The thickness of the stems is one-seventh of the height and the inclination of the Italics has a base of 3 to a height of 8. The relative exterior widths and height of the Roman capitals are the same as those of the U. S. Coast Survey with but very few slight variations. The greatest difference in form is perhaps seen on comparing the O in the two standards. When referred to the unit adopted in Art. 4, the height of the capitals is $6\frac{1}{2}$ units and the width of stem a little less than a unit. These letters are therefore somewhat lighter than those of the Coast Survey.

On Plate XXXIV the lettering on boundary lines and on the margins of plates are illustrated, and a series of guide lines are drawn to serve as a gauge, the heights being expressed in decimillimeters.

A part of the Anthracite sheet of Colorado is shown on Plate XXXV and contains a good selection of the standard styles of lettering as applied to the maps issued by the survey. The scale is 1:62,500. This is one of the specimens published in 1893 in the Manual of Topographic Methods by HENRY GANNETT, the Chief Topographer of the Survey, and is here republished, together with the standard of letter-

ing, by permission. Plates XXXIII-XXXV were printed from stone by means of transfers taken from the engraved plates.

ART. 45. LETTERING ON PATENT OFFICE
DRAWINGS.

The Patent Office requires the plainest lettering on all drawings submitted as a part of the application of patents. The following paragraph relating to letters of reference is taken from "Rules of Practice in the United States Patent Office. Revised April 1, 1892," a pamphlet which should be in the hands of every one who has occasion to prepare such drawings.

The different views should be consecutively numbered. Letters and figures of reference must be carefully formed. They should, if possible, measure at least one-eighth of an inch in height, so that they may bear reduction to one-twenty-fourth of an inch and they may be much larger when there is sufficient room. They must be so placed in the close and complex parts of drawings as not to interfere with a thorough comprehension of the same, and therefore should rarely cross or mingle with the lines. When necessarily grouped around a certain part, they should be placed at a little distance, where there is available space, and connected by short broken lines with the parts to which they refer. They must never appear upon shaded surfaces, and when it is difficult to avoid this, a blank space must be left in the shading where the letter occurs, so that it shall appear perfectly distinct and separate from the work. If the same part of an invention appear in more than one view of the drawing it must always be represented by the same character, and the same character must never be used to designate different parts

The specimen drawing which accompanies the rules is lettered in stump writing, and this is the style recommended by the Patent Office and used by its draftsmen when they prepare drawings for inventors.

ART. 46. LETTERING ON ARCHITECTURAL
DRAWINGS.

As a rule, the lettering on architectural drawings is somewhat lighter in weight than that on engineering drawings, and is not so severely simple in form. Where the artistic element enters prominently into a drawing the letters are modified in form as well as weight so as to harmonize with their surroundings. Most of them are drawn free-hand.

When the modern Roman is used it is either left open or the stem is reduced to about one-half, while the height is increased. The finished Roman is always left open. The Roman old style is more appropriate than the modern, and the regular width of the stem is often maintained. Either this style, with the stem reduced to one-half, or the hair-line Antique (see Plate XI, line 4), is well adapted for the titles of mounted photographs of buildings.

The Roman old style is more frequently employed in a modified than in the normal proportion. The principal change consists in raising the intermediate horizontal lines.

thereby producing what are termed "high-waisted" letters. Those that in the normal proportion are just above the $\frac{1}{2}$ guide line may be moved up to the $\frac{3}{4}$ guide line, but if they go beyond that the legibility is reduced. The height usually ranges from 8 to 10 units, and some of the letters, like M and W, are changed by shortening the middle limbs, as shown on Plate XVIII, which contains a number of styles that are suitable for architectural drawings. Modifications in the size and form of the serifs also serve to give variety when desired. The first title on that plate has letters of the same general form as the normal Roman old style, but with the limbs of a uniform width, those in the last line being $\frac{1}{2}$ and the others $\frac{3}{4}$. The Roman old style small letters make an effective title if it is desired to confine it to a very limited area.

For working drawings the Gothic letters are used extensively when modified in a similar manner, as shown in the lower left-hand title on the same plate. This form is easily constructed and presents a good appearance when properly spaced. The lettering on floor plans may be in Gothic capitals of the normal or modified forms, or in the corresponding small letters, which are either plain or like those in the second group of notes on Plate XIX.

The line "Design of Water Tower," shows the effect of

adding prominent serifs to letters composed of light lines throughout. This style may be used on a composition sketch. Another style which is especially appropriate for such sketches is the upper one given on Plate XXIII. It was designed by BENJAMIN S. HUBBELL, and is not only unique in the general form of the letters, but also in the details of the serifs. This letter has a considerable range of application to other drawings than the kind specified. It will be observed that the short letters are only one-third as high as the ascending ones. The lower alphabet on the same plate is similar to the printing type known as "Outing," and differs from it mainly in securing a higher degree of legibility by lowering the intermediate horizontal lines. The serifs consist simply in an enlargement of the ends of the limbs.

Water color sketches require very light letters approaching the hair-line if in black, or they may be made heavier and executed in some lighter color which harmonizes with those on the sketch. Letters in neutral tint, or some other subdued color, may also be occasionally used on one-line titles for photographs or very light line drawings.

The letters on Plate XI are all appropriate to architectural drawings, as is indicated by the subject matter of the titles or sub-titles. The proportions and characteristics of these forms were described in Arts. 13 and 14.

Many of the styles employed in practice approach very nearly to illegibility, including even those on working drawings. Some of them are of such odd and irregular forms, and so utterly devoid of beauty as to raise the question why they were ever introduced. The most desirable letters are those composed of a few simple parts, and whose merit lies in the shape of their characteristic elements and not in extra attachments or adornments.

The extension of the limbs of letters beyond the outer guide lines should be made sparingly, and the form and direction of serifs varied but slightly from the standard forms.

ART. 47. LETTERING ON ENGINEERING DRAWINGS.

The most appropriate lettering for engineering drawings is simple in form, comparatively free from any attempt at artistic display, and moderate in weight. The plain Roman and Gothic styles are used more than any other and their application to different kinds of drawings is described in Arts. 40 and 42. The merits of the Roman Old Style are so decided that it seems strange why it has been almost entirely excluded from use by engineering draftsmen.

The style used in the first title on Plate XVIII may also be commended as a useful one for fine drawings, the thickness of the limbs being uniform. Their width may be varied

from $\frac{1}{2}$ to $\frac{3}{4}$. It has not been customary to employ "high-waisted" letters for this purpose, although a slight elevation of the intermediate horizontal limbs might not be objectionable. Where instruments are employed in the construction it is usually an economy of time to adhere to the standard forms and thus more quickly acquire perfect facility in the execution.

The modifications in serifs and in the weight of stems which have been described in the previous chapters may be used to advantage, provided all the lettering on any sheet is confined to a single style. The good effect of using only one style in a title has already been noticed, but the commendation of that practice should not be construed as being entirely opposed to the use of minor modifications of the same general style.

The practice of filling up the open forms of the Roman and Gothic letters with all sorts of incongruous designs is to be heartily discouraged. It not only consumes a great deal of valuable time, but the results do more than anything else to spoil the appearance of any respectable drawing, and to discredit the draftsman. If these supposed ornaments are added for the sake of hiding the crude drawing of the outlines of the letters the expedient may be regarded as of doubtful value.

There are a number of styles which have been used quite extensively, concerning whose lack of merit an entire chapter might be written, but attention will be called to only two of them. The first is the block letter shown in the first line of Fig. 21. This style is probably used in most cases because the outline consists of nothing but right lines. The number of lines in the letter S, for instance, when compared with the Gothic S is so great that the difference in time required to draw freehand curves instead of right lines is far overbalanced. If the diagonal lines are not

BOSTON-8
 SHADOW!

Fig. 21.

located with special care, or if the inked line does not follow the exact location in pencil, the fact is quite apparent. If the diagonal lines are omitted the form becomes what is known as the geometric letter, which is still more objectionable, because it is one of the most illegible styles, to say nothing of

the violation of the most elementary artistic principle by the substitution of right angles for all curves.

The second style is also indicated in Fig. 21 as a shadow cast by an imaginary object. It merely suggests letters, and in a specimen book of one of the type foundries this style is perhaps not inappropriately named "Hades."

ART. 48. MAP LETTERING.

An important distinction, which is extensively, but by no means universally, adopted is that which puts names and words connected with land in vertical letters and those connected with water in inclined letters.

The position for the various names should be so chosen as not to leave any doubt as to what each one belongs. Names of places are preferably put immediately to the right of the convention which designates its location, or as near to this as the preceding rule and the position of other names and conventions will permit without the appearance of crowding. They are all arranged in lines parallel to the lower border of the drawing, with equivalent spaces of either $2\frac{1}{2}$ or 3 units, depending upon the relative amount of lettering. The latter is in general to be preferred.

The names of divisions, like districts, townships, counties and States, should have the letters spaced to make the

names cover the larger portion of the division, the lines being graceful sweeping curves extending in the direction of the greatest length and placed approximately along the middle of the width. The character of the curve ought to have the controlling influence, while "approximately" in the above statement is given a broad interpretation. The names of communications, like roads or canals, and those of rivers or creeks are placed by their sides, the spaces between letters and words being considerably increased, the latter proportionately more than the former. If space is equally available on both sides, the letters are placed with their bases toward the convention. On maps of large scale the letters are placed within the lines defining the width. A very long stream or line of communication may have its name repeated, if desirable, at different portions of its length. In all cases the lettering should be arranged so as to be read by the least possible change in the position of the observer when the map lies squarely before him.

The spacing of letters when separated more than four or five units will be sufficiently precise if their distances, center to center, are made the same, except in the cases of I and W, the distance next to I being reduced about 2 units, and those next to W increased about $1\frac{1}{2}$ units.

The relative size of the letters depends upon the relative

importance of the objects themselves, while the actual size also depends upon the scale of the map, and, to some degree, upon the size of the sheet. A study of the standards adopted by the Coast Survey relating to size, given on Plates XXVI-XXIX, will enable the student to extend the application of the principle involved to larger scales than those used on the charts of the Survey.

On a pen topographical drawing, where the entire surface of the map is covered by conventions, the lettering should be done (at least in pencil) before the topographical conventions are drawn, the lines of the latter, if as heavy as the hair-lines of the letters, being stopped before reaching them, thus leaving a narrow white margin around them to maintain or increase their legibility. In all other cases the lettering is constructed in pencil, either during the progress of the rest of the drawing, or when that is completed, the inking of the letters being the last operation except inking the border.

As the course in tinting usually precedes the course in lettering, students will have learned by experience, if not by precept, that it is usually not advisable to attempt to tint over heavy inked lines, and hence that the lettering on all surfaces to be tinted should be inked in after the tinting is completed.

The sizes, spacing, location and character of lettering on maps is illustrated on Plates XXIV, XXXII, XXXV, and XXXVII, which ought to be critically examined. Plate XXIV was designed and drawn by EDWARD MOLITOR especially for this work and gives letters of considerable variety, both in character and in their relation to numerous conventions of topographic features and aids to navigation. The drawing explains itself and requires no extended description. The student's attention is however directed to the toning down of the topographic signs near the letters, in order to make the latter stand out more clearly.

The Roman is the most appropriate style of letter for fine maps executed with the pen, as the plates just mentioned may indicate when compared with maps in which only other letters are used. A map of the Croton Aqueduct and Watersheds on which upright and inclined Gothic letters are exclusive employed was published in the Commissioners' report of 1887. This map, although not as handsome as one lettered in Roman, presents a good appearance and requires less labor. In the same report and also in that of 1895 are shown profiles and plans of various kinds lettered in the same style. The effect of using free-hand Gothic letters on an outline map may be seen on Plate XXV, which is reprinted, by permission, from Sewage Disposal in the United States by

RAFTER and BAKER. The characteristic style of the lettering will be recognized at once by all readers of the *Engineering News*. From a number of maps executed in the same style those may be selected which were published in *Engineering News*, Sept. 30, 1893 (inset), and May 30, 1895.

In a city map where the names and numbers of districts must occupy a space which is entirely covered by other details, an open letter of somewhat larger size, whose surface is cross-sectioned with light lines, may be used in preference to a smaller solid letter which would obscure some of the details.

Colored topographical maps need light letters such as the hair line antique or Gothic, or the Roman with the stems reduced to $\frac{1}{2}$ or a little less. Open letters without shading may also be employed, but it is well to use them sparingly.

Where for any reason the names of some features cannot be placed on the map in the usual way, reference numbers or letters may be used to designate the features, the names being given in a key or index on some other part of the sheet.

ART. 49. LETTERING TRACINGS FOR BLUE PRINTING.

The extensive use of blue prints as working drawings requires certain precautions in the preparation of the tracings. As mistakes in reading the dimensions on a blue print may

be very expensive, their occurrence should be reduced to a minimum by insuring as perfect legibility as possible on the drawing.

The letters and especially the numerals should be of the utmost simplicity in form and of uniform thickness throughout. The Gothic style is therefore the most suitable. Legibility is improved by making them round and open rather than narrow and high. The instructions quoted in Art. 45, with reference to mixing up letters with the lines of the drawing are also applicable here. All hair lines should be avoided, as they sometimes fail to print or at least print indistinctly. While the lines should be somewhat thicker than are required on other drawings it is equally as important that only thoroughly black ink should be used. The dimensions should be marked in characters of sufficient size so as to be easily read when placed at a distance of several feet from the workman, and this implies that the interior spaces must not be reduced for the sake of increasing the weight of the lines.

The construction of titles in free-hand lettering on tracings may be simplified from the usual method in the following manner: Find by the diagram the width of the average letter in order to produce a line of the desired length; with

this width in mind, sketch the title by eye in pencil, find the center and trace the line in its proper position.

ART. 50. LETTERING FOR PHOTO-MECHANICAL REPRODUCTION.

The photo-mechanical processes for reproducing line drawings in most common use are photo-engraving and photolithography.

The best paper on which to make drawings for reproduction has a smooth surface, on which the lines will remain sharp and clear. It is also a desirable quality if the surface of the paper will admit of erasures with a sharp knife without cutting into the fibre and thus allow inking over the erasure without producing lines with ragged edges. Some qualities of cardboard possess these qualifications, but the highest priced quality is not always as good as a lower grade, owing to the method of finishing. Marked differences are found in this respect between the cream-tinted and the blue-white paper of the same grade. Of the regular drawing papers, the "hot pressed" is better than the "not hot pressed."

In employing tracing cloth, CHAS. W. REINHARDT recommends removing the gloss from the smooth side by means of powdered pumice, to facilitate making sharp and un-

broken lines, and to apply the same powder to the tip of the finger in making erasures, as the surface thereby remains intact and the ink will not spread when the line is redrawn.

The ink should be perfectly black and not flow too easily. By frequently cleaning the pen the lines may be drawn more rapidly and yet be clear. The waterproof inks are found to answer the purpose well and to stand cleaning better than the other kinds. The pencils used should be suited to the paper, be as soft as possible and pressed lightly on the paper in drawing so as not to require much effort in erasing the parts of lines which are not covered by the ink. By keeping the pencil well pointed the lines may be sharp without being heavy. An expedient for keeping the drawing clean and thereby avoiding additional erasing is described in Art. 53.

Due allowance must be made for the amount of the reduction, in deciding upon the thickness of lines, the clear width between the lines, and the size of the lettering. Fig. 22 shows the parallel full lines at near the limit of reduction, and the character of the dotted lines in the figure indicate that the dots or short dashes on the originals were too small. On the proofs, which were taken on heavy glazed paper, the impression was excellent, but the electrotpe made from the

zinc etching gives the result shown above. Photo-lithography will reproduce finer lines satisfactorily than photo-engraving, but the lines obtained by the former method are

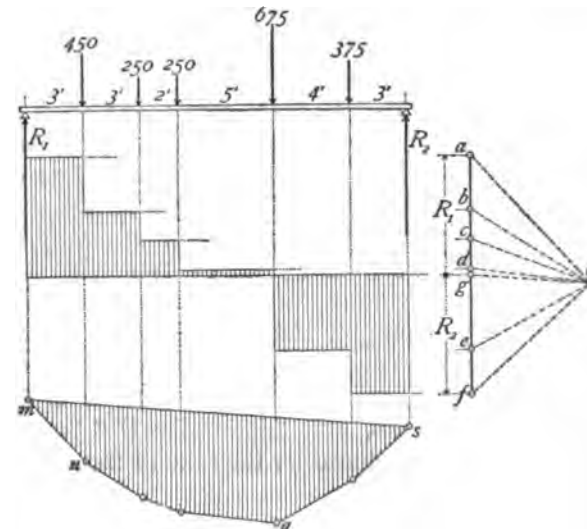


Fig. 22.

not as sharply defined as by the latter. In the rules issued by the American Society of Civil Engineers in a bulletin of May 11, 1894, it is recommended that "the width of lines must

be such as not to become less than $\frac{1}{32}$ inch when reduced. Spaces between lines must not be less than $\frac{1}{64}$ inch after reduction. Lettering and dimension figuring must not be less than $\frac{1}{32}$ inch after reduction. Omit ornamental titles; * * * display titles are sources of needless expense, as well as obstacles to suitable reduction." The rest of the rules relate to various other details and should be consulted by draftsmen.

The minimum size of the reduced lettering, here specified, is about that of the numbers designating the guide lines on Plate VIII. The linear dimensions of the reductions should be at least $\frac{1}{4}$ less than the original. A very convenient ratio is to make the reduction $\frac{1}{2}$. When the reduced drawing measures only one-fourth of the original it is technically called a $\frac{3}{4}$ reduction.

With the higher reduction ratios special care must be exercised to give the hair lines of Roman letters and numerals sufficient thickness. The Gothic numerals whose limbs are $\frac{1}{2}$ unit thick permit a larger reduction than letters with hair lines, and are more legible than if the limbs were made 1 unit wide. The letters should be left perfectly plain and without any shading.

Where a large number of individual letters of reference or measurements are to be placed on a drawing and it is de-

sired, for any reason, to use a style of letter like the Roman, considerable time may be saved and good results produced by using metal type to stamp the letters in their proper positions. This process is described in Art. 55. The originals from which Figs. 22 and 23 were obtained were lettered

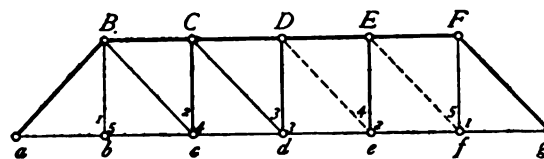
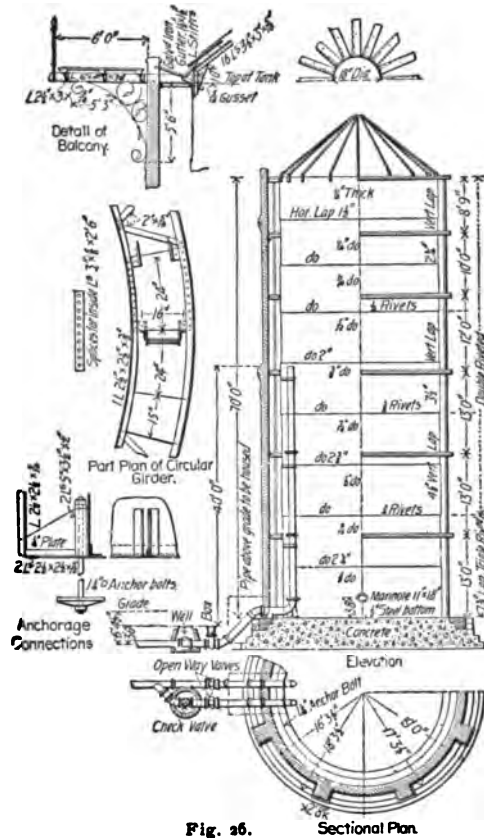


Fig. 23.

in this manner. The lettering of titles and maps on a more extensive scale will be described in Art. 56.

If a table or explanatory notes are to be inserted on a plate, a still more economical arrangement may be to have it set up in type by a printer, have an impression taken on good paper with a smooth surface and paste it on the sheet to be reduced. The fine lines between the columns may require to be strengthened by inking over them with the right line pen.

Titles might also be treated in the same manner, and Plates XLVI and XLVII show what effects may be produced by a proper selection of sizes of a single style of letter



ART. 51. FREE-HAND LETTERING.

A number of references to this subject have been made in previous articles, especially in Art. 35, and need to be supplemented here only by some general hints that have been tested by experience.

For the finest lines Gillott's lithographic pen, and for the medium lines No. 303 of the same make, are found to give excellent service. When new the pens will make finer lines than after being used awhile, and it is convenient to have on hand both new and old pens and to employ them as occasion demands. In making letters of uniform weight the pen, paper and ink should be so co-ordinated that no decided pressure is required. The hand will experience less weariness and the lines will be more uniform. If heavier lines are to be made with a single stroke, coarser round-pointed pens may be selected. A well-worn 303 pen will be found admirably adapted for filling in the larger letters, and a new one for the smaller ones. The surface of the paper largely determines the quality of the line made by any pen. To clean the pen frequently on a piece of chamois skin will increase the ease and possible speed of its movements.

Special care should be used that vertical lines shall appear truly vertical and it will materially aid the draftsman to make them so, if the drawing is kept squarely in front of him.

The Gothic Style is especially adapted to rapid free-hand lettering, and, if well made, is appropriate to many drawings besides purely "working drawings." Condensed free-hand letters are not quite as legible as the rounder forms, but ellipses are more easily drawn than true circles. As a rule the pen should do its principal work on downward strokes, but portions of limbs may be drawn on a side stroke or a very slight upward movement. When inking free-hand letters outlined in pencil, time may be saved and the execution improved by omitting the horizontal lines until the others are finished and then shifting the drawing or his own position, so as to draw the horizontal strokes directly toward the draftsman.

The main difficulty experienced by the beginner is in avoiding the rounded ink spots where two lines meet at an acute angle. To keep these joints clean enhances the beauty of any lettering. Three guide lines for the capitals and four for the small letters are sufficient for the sizes usually required in free-hand lettering. After the student has constructed the alphabet several times to scale he will become familiar with the relative widths of the letters and should be able to secure them approximately by eye. In case a tendency is discovered to make any letter either too wide or too narrow, a decided effort should be promptly

made to correct it. Failure to do this frequently leads to the definite formation of a wrong habit.

In exercises for practice the principal attention should at first be given to form and proportion, and afterwards to securing speed in construction. Every draftsman should be able to do free-hand lettering neatly and rapidly. Explanatory notes and bills of material, to be placed on one of the sheets containing the plans of some standard structure, may serve as exercises. An article on Free-hand Slanting Lettering for Working Drawings, by CHAS. W. REINHARDT, Chief Draftsman of the *Engineering News*, was published in that periodical, volume XXXIII, page 381, June 13, 1895. An analysis is made of each letter of the Gothic style and the finished letters compared with others improperly constructed.

ART. 52. PRINTING TYPE.

A careful selection of specimens of printers' type is shown on Plates XLI-XLV, and was made for the purpose of furnishing additional illustrations of the effect of modifying the proportions and details of the most important styles; to enable a comparison to be made in a few cases between the type faces and the manuscript forms of the same style, and to supply further suggestions to draftsmen who are interested in designing new styles for their own use.

Considerable improvement has been made in this country in recent years in the cutting of new faces, and the tendency has been to avoid a preponderance of ornament and to design simpler shapes of considerable merit. The revival of the old-style faces which preceded this movement led to the imitation of their excellent constructive features in the new designs, as opposed to the combination of extremely fine hair lines with heavy stems, which characterized many of the modern faces.

The Roman Old Style may be regarded as the standard book type and at present the French Old Style is rapidly increasing in favor for a variety of purposes. The revived old faces and the newer designs bid fair to gradually displace those which were distinguished by fantastic forms and complicated shadings.

There has also been a corresponding improvement in the spacing of type by the careful adjustment of the face to the body of the type and by placing offsets on the type bodies of letters like A, T, V, W, Y, etc., which allow them to interlock whenever two come together whose greater widths are at the top and bottom respectively.

The Cushing on Plate XLII is one of the new styles which has the uniform lines of the Gothic combined with the form and general proportion of the Roman Old Style.

The Elandkay on Plate XLIII is an exceedingly neat and attractive style. The only letters which may be criticised are the alternate forms of P and R, in which the inclined lines meet the vertical limbs too far below the line of the intermediate horizontals of the other letters.

The Capitals of the Art Gothic are not intended to be used alone. The entire alphabet might serve as a guide for a light free-hand letter without serifs.

The Dynamo may be imitated in its general features by a free-hand construction with a coarse round-pointed pen, its weight being somewhat reduced. All of the styles on this plate are appropriate for architectural drawings.

The De Vinne on Plate XLIV is a bold faced alphabet of pleasing shape with distinctive substitutes for the spurs or hooks of C, G and S. The alternate form of M, however, is out of harmony with the rest of the letters and R is even weaker constructively than the same letter in French Old Style.

Quaint Open is inserted here, as it is not so heavy as the Quaint. In general its shape does not differ much from Outing.

The Old Style Antique No. 2 is a strong, simple letter. The curves at the serifs are round and full and the ends of the serifs pointed like those in the French Old Style. M

might be improved by widening it a half unit and reducing the upper width of the joint between the vertical and inclined limbs. The inclined limb of R should have its outer edge straight.

The Antique on Plate XLV has been extensively employed for one-line titles of plates in Architectural publications.

The angular serifs of the Cloister and Light Face Celtic in lines 7 and 9 are not more easily constructed than those of the Old Style Antique or the Celtic, and they certainly do not look as well. The shading applied to two of the styles

is similar to that sometimes used on Gothic letters. The Roman Old Style is not improved by shade lines. The seventh line in the second column shows that if a letter is well proportioned it requires very rough execution before its good appearance is materially impaired. The next line contains a modern Roman capital with prominent curved fillers at the serifs, and the curves on the hooks of E extending back farther than usual. The last line shows a light face Roman with serifs of the French form, an extreme style which should not be imitated in manuscript letters.

CHAP. V. MECHANICAL AIDS.

ART. 53. LETTERING TRIANGLES.

Most of the manufacturers of mathematical instruments advertise "lettering triangles," which it is supposed are made to facilitate the construction of letters having inclined rectilinear members and to economize the time of the draftsman.

In order to test the value of these appliances, the Gothic capitals in Fig. 27 were drawn by means of the triangles, designed for condensed and extended letters, the third of the series being used for letters intermediate between these in proportion. Taking the N as a standard by which to determine the scale for measuring the widths of the letters for the purpose of comparison, the top of X is found to be 5 when the bottom is made $5\frac{1}{2}$, the stem being $\frac{1}{2}$. If the bottom were increased to 6, the top would be reduced to $4\frac{1}{2}$. The top of Y is also 5 when the vertical stem extends to the middle. The width of A, V and M is $5\frac{1}{2}$, and of W is $6\frac{1}{2}$. By giving to K the widths of 5 and $5\frac{1}{2}$, the stems

assume the relative positions shown in the figure. The heights are $7\frac{1}{4}$ and $5\frac{3}{8}$ respectively.

If the stems were made unity, the widths of N, A, V, M

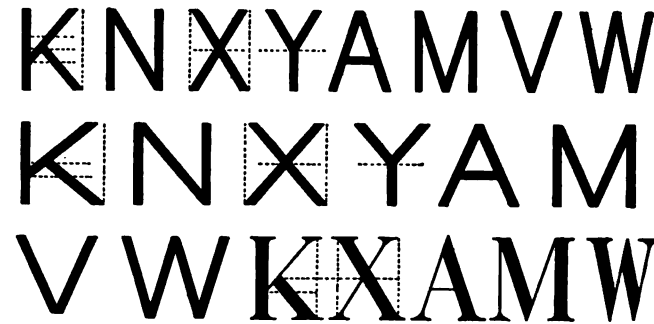


Fig. 27.

and W would be $5\frac{1}{2}$, 6, 6, 6 and 7, respectively, and the top of X would be $5\frac{1}{2}$ for a width of 6 at the bottom. It is seen, therefore, that the triangles give good proportions

for these letters of the Gothic style, with the exception of W, only when the stems have a given width. For hair-line letters the corresponding widths would be $4\frac{1}{4}$, 5, 5, 5 and 6.

Several of the Roman capitals are also given, as constructed with the triangle for condensed letters, the resulting widths of A, M and W being $5\frac{1}{4}$, 6 and $5\frac{1}{4}$, while the top of X is $4\frac{5}{8}$ when the bottom is $5\frac{1}{2}$. These measurements of X, M and W would also be modified on changing the width of the stems.

As the angles of inclination vary not only for different heights of letters, but also for changes in width of stem, it seems evident that no lettering triangles can be made which will meet the necessary conditions as conveniently as a triangle of the usual form, in combination with the paper scales, whose use has already been fully explained. In their present form their range is too limited, even if the expected economy of time, resulting from their use, could be realized.

The attention of students is, however, called to one of the forms of triangles (Fig. 28) which has been proved by the author's experience to possess certain advantages in manipulation, which, in the aggregate, save considerable time. It is known as Kelsey's combination triangle. The size

which is most convenient for lettering is about four inches high and combines angles of 90, 45, 15, 30 and 60 degrees in one triangle in such a way that one angle will not be confused with another. This form was obtained by cutting out of a 45-degree right triangle an isosceles triangle, whose base is on the hypotenuse of the former one, and whose angles adjacent to the base are fifteen degrees.

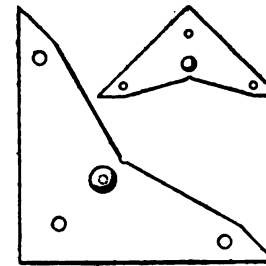


Fig. 28.

When lines of 45 or 15 degrees are to be drawn, the triangle is placed with its hypotenuse against the straightedge, while in its usual position the sides of the isosceles notch give the angles of 60 and 30 degrees on both sides of a vertical, the other side giving the perpendiculars. The most convenient feature of the triangle, however, is a small handle, with a milled head attached to its center

of gravity, while a slight curvature in the body of the transparent material, of which it is composed, prevents it from rubbing dust particles over the surface of the paper. If the draftsman will also paste a strip of thin blotting paper not quite as wide as the blade on the under side of his T square, he may easily keep his drawing clean without the

use of an eraser, even if it be drawn on the finest white cardboard and requires a number of days to complete it.

A small triangle is made by THEO. ALTENEDER & SONS of Philadelphia which contains the angles of $69\frac{1}{2}$ and $74\frac{1}{4}$ degrees adjacent to the same edge. The use of this triangle facilitates the construction of italic letters for the two most desirable inclinations (Art. 7), and not only saves time but avoids the necessity of constructing the inclinations by means of their co-ordinates and transferring them in the usual way, during which operation the T-square is not in its normal position on the drawing board.

ART. 54. STENCIL PLATES.

Stencil plates may be used to advantage in lettering maps or diagrams drawn to a large scale such as are frequently used for class-room illustrations. When the lettering is to be neatly executed in India ink instead of adopting the cheaper and coarser method of applying a colored paste with a stiff brush, the partial outlines are drawn in pencil, completed on removing the stencil, and afterwards filled in with a pen or brush. Stencil frames may be obtained allowing the plates to be adjusted on account of the spacing before any part of a word is marked on the regular sheet.

Where names have to be extended along curves of con-

siderable length the use of splines will facilitate the location of curves of good form, which frequently have to be irregular, compound or reversed curves in order to distribute the letters to the best advantage over the required area.

ART. 55. LETTERING WITH METALLIC TYPE.

In the preparation of drawings to be reproduced by photolithography or photo-engraving for use in books or reports either as illustrations in the text or as plates, it is often required to repeat the same letters or numerals a considerable number of times, as, for instance, in placing individual letters at various points of geometrical or other diagrams and in marking the soundings on the map of a lake or harbor. In such cases excellent results can be secured and with a material saving of time by using metal type.

The drawing is placed on a horizontal plane surface with a sheet of blotting paper beneath it. At its side the type is arranged in regular alphabetical and numerical order, and a roller having a light coating of the best black printers' ink, placed in convenient position. A type is clamped in a small holder like that illustrated in Fig. 29 and after touching the ink roller the type is firmly pressed on the drawing in its proper position. The ink should be medium thin, well worked, and distributed evenly over the roller. At first the

type needs to be touched to the roller several times until it is thoroughly covered with ink and on testing it prints a solid black. Afterwards only one or two contacts are usually required. A convenient size of type-holder is just large enough to hold about two ems and with a clamp screw of such length that no quad is needed when the narrowest

single type is inserted. If it is desired to use more than two types at once it is preferable to have another larger holder in which, however, they must be approximately centered so that the pressure may be applied uniformly. In manipulating the holder let the fore finger be placed on top of the handle and the body of the holder grasped firmly between the thumb and remaining fingers. To make sure that all the edges of the type are in contact with the paper, a slight

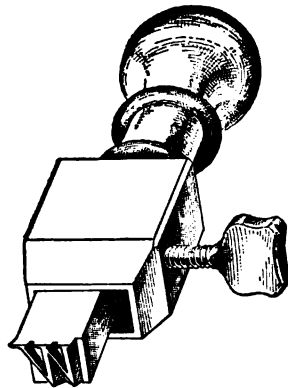


Fig. 29.

rocking motion may be given to the holder just before releasing the pressure.

If no lines of the drawing are parallel to the direction of the bases of the letters, it is desirable to draw a few pencil

lines as a guide in orienting the holder before the type touches the paper. Should some impression not be quite perfect it is usually a fruitless attempt to try to make a second impression, as the least shifting of position will make matters worse. Such occasional deficiencies may be corrected with the pen. The impression should be fairly strong or else the hair-lines will not come out full if reduced considerably in photo-engraving.

To draw a large number of small Roman numerals is both a tedious and a difficult task, while with type the forms will not only be absolutely uniform, but will bear a greater

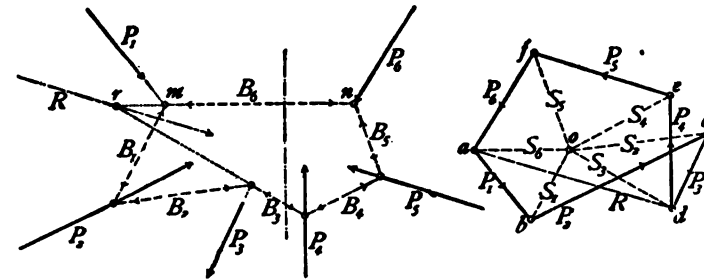


Fig. 30.

amount of reduction and still remain legible than when drawn by hand. Numerous soundings in a harbor, such as

are shown on Plate XXXII, may be inserted very rapidly since the same numbers are so frequently repeated.

Figs. 30 and 31, as well as 22 and 23, were produced from diagrams which were lettered in the manner described

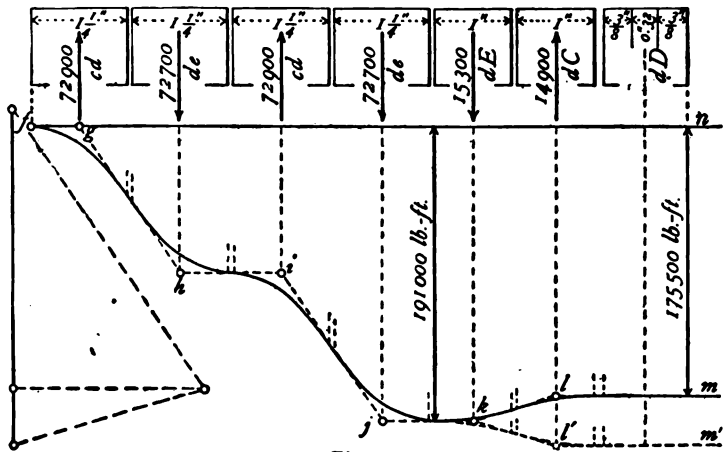


Fig. 31.

above. As the text-books for which they were prepared (Roofs and Bridges, Parts II and III, by MERRIMAN and JACOBY) are printed in Roman Old Style, the corresponding Italic type was used for nearly all the illustrations in the text.

ART. 56. MECHANICAL MAP LETTERING.

Plates XXXVI and XXXVII are photo-lithographs of the title and a portion of Chart No. 143, published by the Mississippi River Commission, on the original of which all the letters, figures and conventional signs were made by devices developed by J. A. OCKERSON, Principal Assistant Engineer of the Commission, who has had charge of the field and office operations pertaining to the detailed survey of the Mississippi River, the devices being used on all the detail map work in that office. The plates will give a better indication of the value of these special devices than any written description.

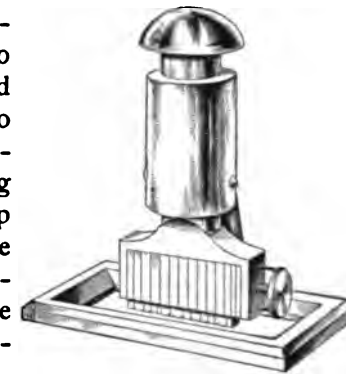


Fig. 32.

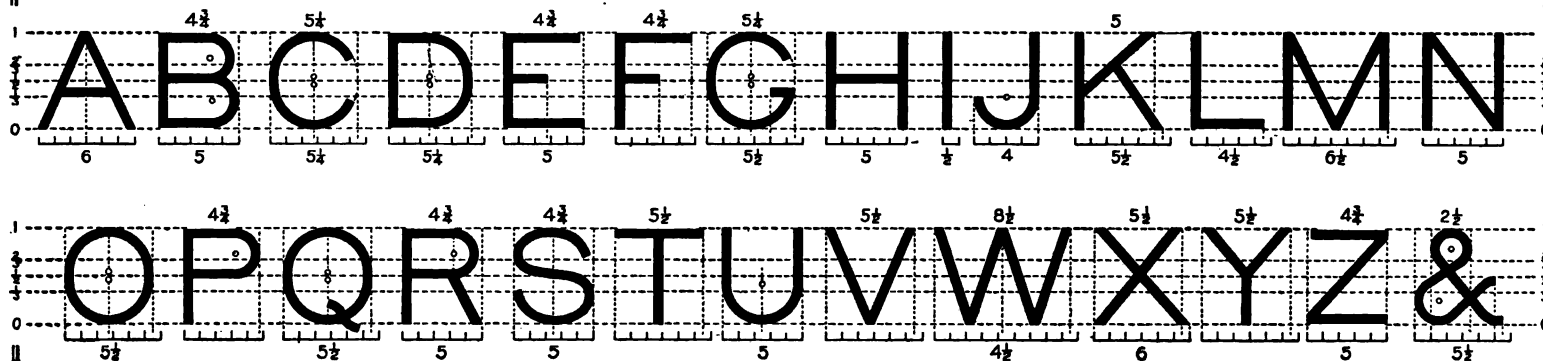
The lettering device is illustrated in Fig. 32 and consists of a stamp having a movable type holder, open on one side, carried by a standard, which is attached to an open rectangular base. The edges and guide marks of the base enable the letters to be properly aligned and centered. For numbering, three revolving disks,

each of which contains the ten integers on projecting type, are so arranged that any number of not more than three figures may be stamped upon the sheet, or the numbers may be printed with the lettering device by clamping the type in the holder.

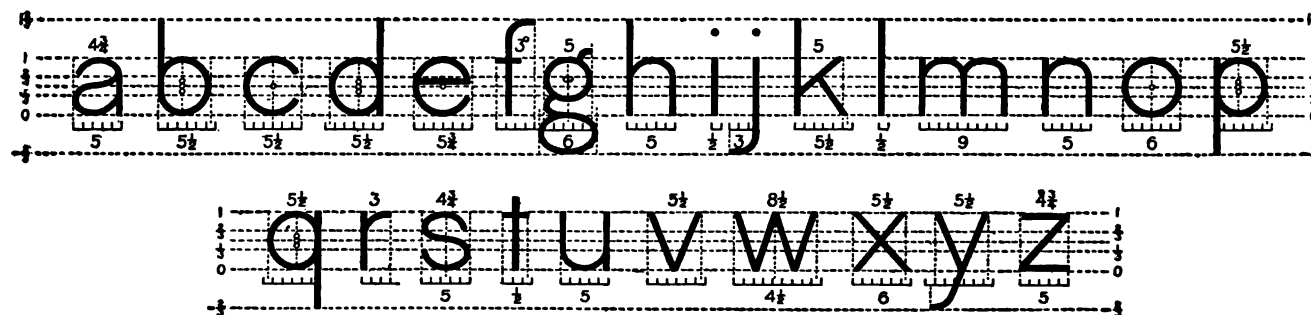
At first the titles and notes were printed with the lettering device by hand, and afterwards a special press was made

which admitted of printing the whole form at once. Now the form is printed on a separate sheet and pasted on the chart. The lettering may be arranged in curves, if required. In case a title is to be reproduced by lithography to the same scale, it may be printed on transfer paper with special ink and transferred directly to the stone. The device is manufactured by A. S. Aloe & Co., of St. Louis.

CONSTRUCTION OF GOTHIC CAPITALS



Construction of Gothic Small



ROMAN

A B C D E F G H I J K L M N O P Q R
S T U V W X Y Z

a b c d e f g h i j k l m n o p q r s t u v w x y z

ITALIC

*A B C D E F G H I J K L M N O P Q R
S T U V W X Y Z*

a b c d e f g h i j k l m n o p q r s t u v w x y z

Stump Writing

a b c d e f g h i j k l m n o p q r s t u v w x y z

HAIRLINE GOTHIC

ABCDEFGHIJKLMNOPQRSTUVWXYZ &
abcdefghijklmnopqrstuvwxyz

INCLINED HAIRLINE GOTHIC

*ABCDEFGHIJKLMNOPQRSTUVWXYZ &
abcdefghijklmnopqrstuvwxyz*

HAIRLINE ANTIQUE

ABCDEFGHIJKLMNOPQRSTUVWXYZ

ANTIQUE

ABCDEFGHIJKLMNOPQRSTUVWXYZ

HAIRLINE GOTHIC

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z &

a b c d e f g h i j k l m n o p q r s t u v w x y z

INCLINED HAIRLINE GOTHIC

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z &

a b c d e f g h i j k l m n o p q r s t u v w x y z

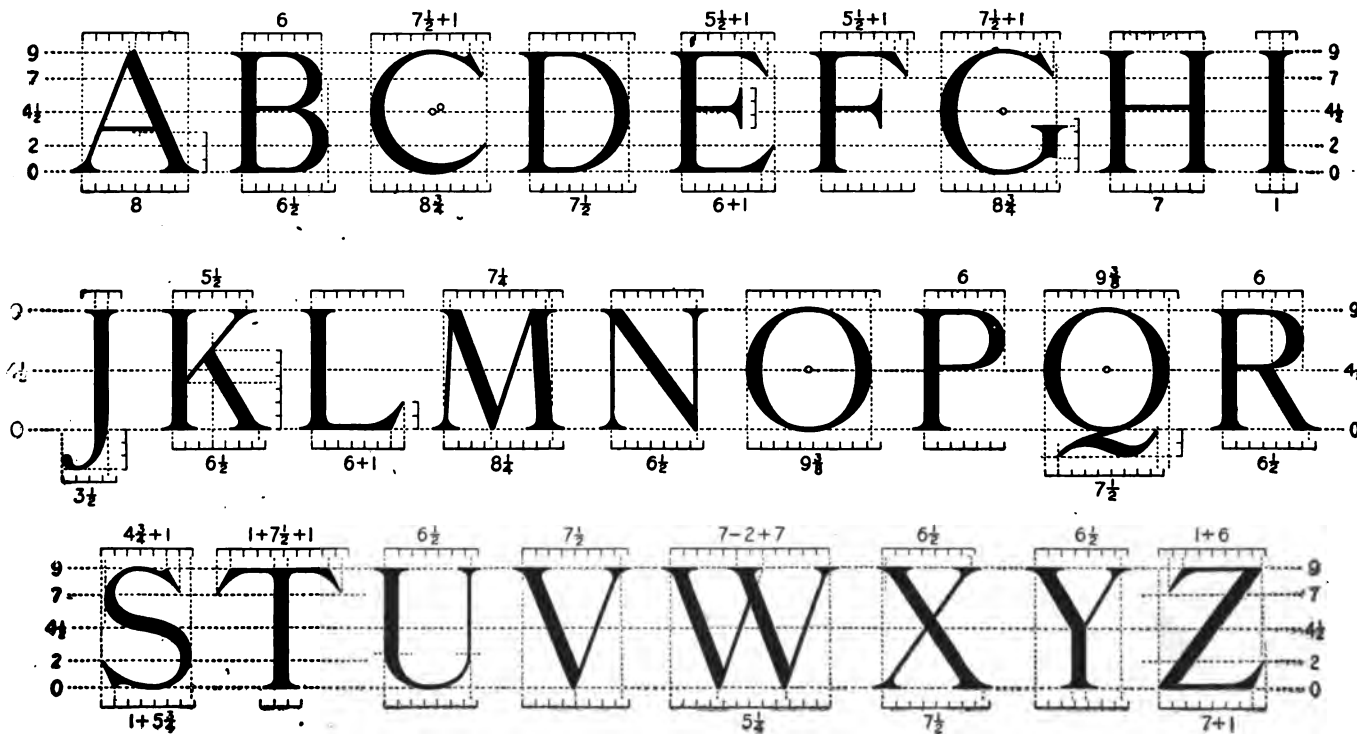
HAIRLINE ANTIQUE

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

ANTIQUE

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

CONSTRUCTION OF ROMAN OLD STYLE



ROMAN OLD STYLE

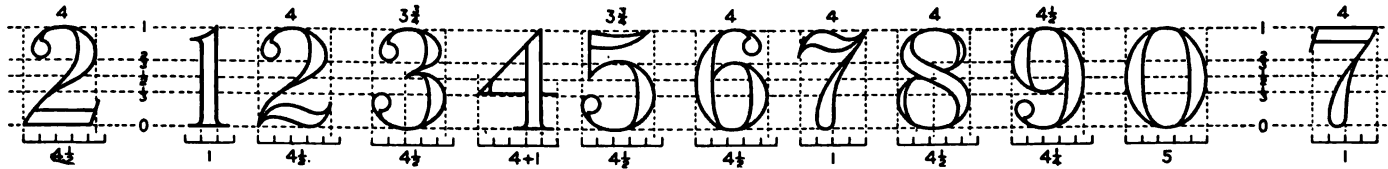
A B C D E F G H I J K L M N O P Q R
S T U V W X Y Z

FRENCH OLD STYLE

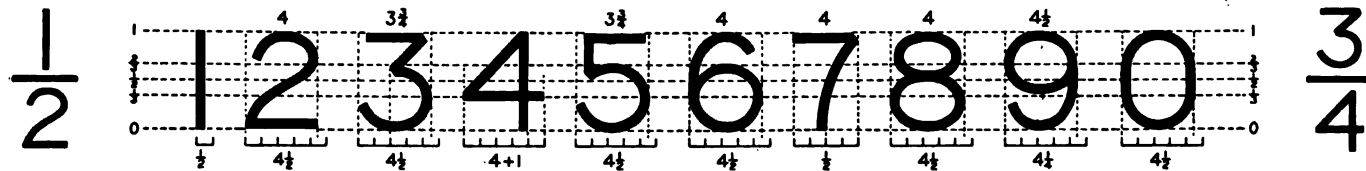
A B C D E F G H I J K L M N O P Q R
S T U V W X Y Z
A B C D E F G H I J K L M N O P Q R
S T V W X Y Z

CONSTRUCTION OF NUMERALS

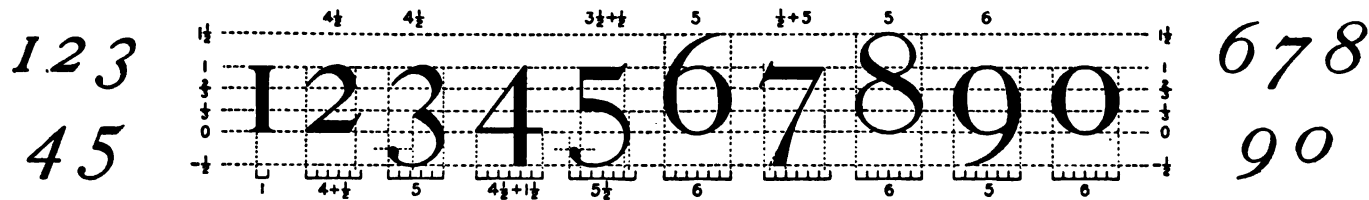
PLATE VIII.



1234567890 23737 1234567890



1234567890 1234567890



Examples of Spacing

ELEVATION	<i>SWITCH STAND</i>
SWAY BRACING	<i>Asphalt Pavement</i>
Precise Levels	<i>Helical Springs</i>
Suburban Division	<i>Three-Throw Switch</i>
Distributing Chamber	<i>Direct-Coupled Generator</i>
Magnetic Declination	<i>Potsdam Sandstone</i>
JETTY CHANNEL	THROTTLE LEVER
MONUMENT	PALACE CAR



One-line Titles or Subtitles

CHAMBER OF COMMERCE, CINCINNATI.
CEILING OF THE NORTH HALL OF THE PARTHENON.
ELEVATION OF WEST FRONT TOWARD VANDERBILT AVENUE
SCREENED NOOK ON STAIRCASE
GOLDEN GATE, TRANSPORTATION BUILDING
DETAIL OF MAIN FIREPLACE
CORNICE AND PARAPET ON ABUTMENT AND PIER
END OF GRAND HALL, LOOKING WEST
THE UNIVERSITY LIBRARY

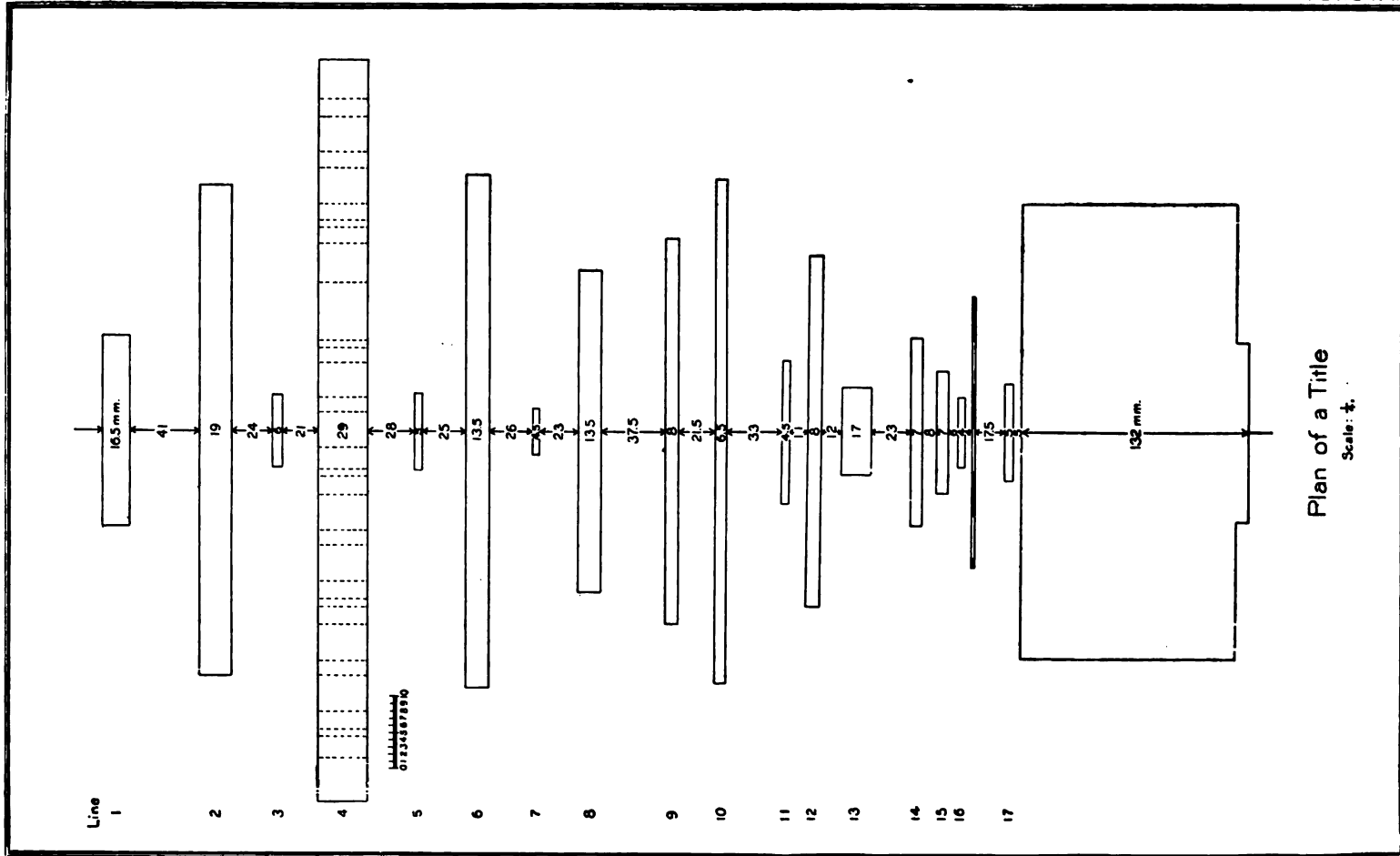
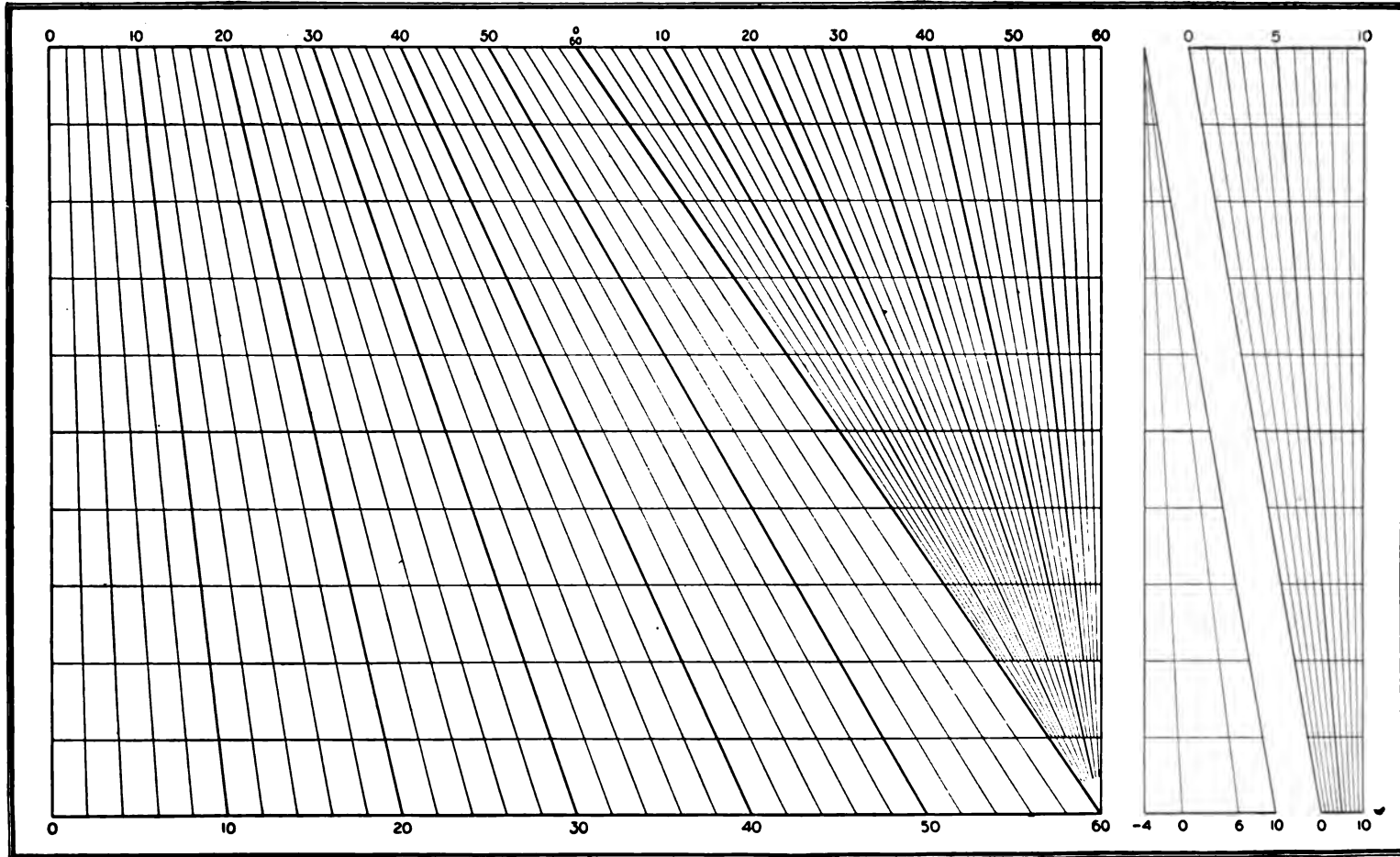




DIAGRAM FOR PROPORTIONING

PLATE XIII.



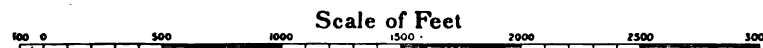
1
2
3
4
5
6
7
8
9
10

DISTRICT OF COLUMBIA
—
MAP OF THE
CITY OF WASHINGTON
SHOWING THE
VARIETIES OF STREET PAVEMENTS

Laid and under contract on Jan 1 1895

To accompany the Annual Report
of the

ENGINEER DEPARTMENT



PLAN

FOR THE

COLLECTION AND DISPOSAL

OF THE SEWAGE OF THE

CITY OF ITHACA

NEW YORK

Scale of Feet

1894

RUDOLPH HERING

CIVIL AND SANITARY ENGINEER

NEW YORK

ASSISTED BY

J. H. FUERTES

CIVIL AND SANITARY ENGINEER

EXPLANATIONS

Proposed Gravitation Sewers shown
 Existing " " "
 Force Mains " " "
 Compressed Air Mains " " "
 Direction of Flow in Sewers " " "
 Ejector Stations " " "
 Flush Tanks " " "
 Manholes " " "

[Signs omitted]

Sizes and Grades of Sewers shown $\frac{8"}{1}$
 Meaning that the sewer is 8 inches in diameter and laid on a slope of $\frac{1}{8}$ foot per 100 feet of length.

The Elevations of Contours are given in feet above or below City Datum.

City Datum is ordinary Lake Level and is 31.5 feet below City Hall Bench Mark.

For Crank see Sheet No. 3398
" Beam " " " 3321

CLASS E

CAMBRIDGE WATER WORKS PUMPING ENGINE N^o 7

CYLINDERS $\frac{18\frac{1}{2} \times 33 \times 52\frac{3}{4}}{90}$, PLUNGERS $\frac{19\frac{3}{8} \times 27\frac{3}{8}}{90}$

CONNECTING ROD

Scale: 3 Ins. to 1 Ft.

April 15, 1895.

Bill of Material
N^o 3742



3294

E. D. LEAVITT, Mechanical Engineer

CAMBRIDGEPORT, MASS.

①
 Trigonometrical connection
 of the
Rockville Latitude Station
 with the
Transcontinental Triangulation
 along or near the 39th parallel

②
Maximum Rainfall
 in
Several American Cities
 as recorded by
Automatic Rain-gages

③
 General Plan
CLARION BRIDGE
 ALLEGHENY VALLEY RAILWAY
 2 Spans, Single Track Through, 185' 10" c. to c. End Pins
 Width 17' 0" c. to c. Trusses, Depth 32' 0" c. to c. Chords
 Scale $\frac{3}{4}$ " to 1 ft
 Pencoyd Iron Works,
 Bridge & Constr. Dept.,
 Pencoyd, Pa., Jan. 4, 1895
 ORDER N^o A 25

④
 CONTRACT N^o 714
 Sheet N^o 20
 DIAGRAM
 OF
ROTUNDA BUILDING
 ILLINOIS CENTRAL R. R. STATION AT 12TH ST., CHICAGO
 Shiffler Bridge Co., Pittsburgh, Pa.
 Scale: $\frac{1}{8}$ Inch per Foot

COMPETITIVE DESIGN
FOR THE
PROPOSED STATE CAPITOL
OF
WASHINGTON

NEW YORK STATE VETERINARY COLLEGE
CORNELL UNIVERSITY ITHACA N Y

C FRANCIS OSBORNE } ASSOCIATED
CLARENCE A MARTIN } ARCHITECTS

DETAILS OF CUT-STONE WORK

SCALE 3 INCHES TO 1 FOOT & FULL SIZE

JULY 5 1895



PERSPECTIVE VIEW
FROM CLIFTON AVENUE
—
PREMIATED DESIGN
FOR THE
MILWAUKEE LIBRARY AND MUSEUM
—
DESIGN FOR WATER TOWER
—
DETAILS OF CONSTRUCTION
A BOURSE
FIREMENS MONUMENT

NOTES

THIS WINDOW IS DETAILED FOR A STONE WALL 18" THICK FURRED 4" INSIDE FOR THE SHUTTER BOX. THIS CAN ONLY BE DONE IN THE BEST WORK. THE SHUTTER BOX IS SOMETIMES OMITTED AS INDICATED ON PLAN, BUT THIS IS OBJECTIONABLE AS IT LEAVES THE EDGES OF SHUTTERS EXPOSED IN THE ROOM. THE WIDTH OF BOX SHOULD BE ADJUSTED TO WIDTH OF SHUTTERS, THE DEPTH OF BOX DEPENDING ON WHETHER SHUTTERS ARE ONE, TWO, OR THREE FOLD. A SERIOUS OBJECTION TO THREE FOLD SHUTTERS AS COMMONLY HUNG IS THAT THE INNER FOLD IS APT TO OPEN AND CATCH IN THE BOX WHEN SHUTTERS ARE DRAWN OUT. THIS CAN BE AVOIDED ONLY BY MAKING THE INNER FOLD VERY NARROW OR BY USING A SPECIAL HINGE AS SHOWN. PANELS IN SHUTTERS MAY BE SOLID PANELS OR ROLLING SLATS.

NOTES

The essential parts of this window frame are the yoke, weight box and sill. These remain practically the same in all double hung windows whether in masonry or frame walls. The outside casing in ordinary work is usually made but $\frac{7}{8}$ " thick, but it is better in good work to make both this casing and the pulley stile $1\frac{1}{8}$ ".

The pulley stile and parting strip should always be hard wood. The width of reveal and jamb can be varied by setting the frame nearer face or back of wall.

NOTE

SHAFTS CONTAINING TWO HOISTING CAGES ARE TO BE SEVENTEEN FEET SIX INCHES BY EIGHT FEET IN THE CLEAR OF ALL ROCK AND OF ALL TIMBER CURBING USED FOR SUPPORTING THE SIDES OF THE SHAFTS

NOTE.—For I truss C make the one base as shown above, the other as shown below. All material steel. All rivets $\frac{3}{4}$ inch diam.

Connecting Rod.

One of this complete.

Body, pins and adjusting screws oil tempered steel forgings. Boxes composition, babbitted. Wedges and keepers wrought iron. All parts finished except at "x" "x". Exposed parts finished bright. Oil grooves to be cut in all boxes.

Forgings to be oil tempered nickel or crucible steel with an elastic limit of not less than 50 000 lbs. per sq. in., and an elongation of not less than 18% in 10 inches in a test piece 1 inch in diameter. One test piece from connecting rod and one from forging from which end pins are cut.

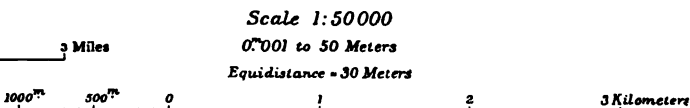
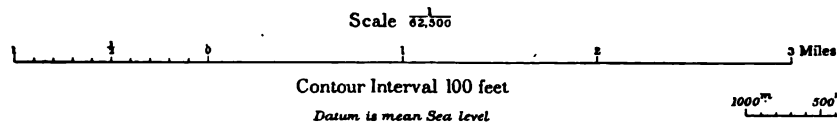
Note: To obtain grip G of pin add $\frac{1}{8}$ inch extra for each bar packed together with the proper additional amount given above in the table.

NOTE.—ALL BOLTS ARE $\frac{3}{4}$ IN. DIAM. WITH STANDARD O.G. WASHERS. ALL SHEATHING TO BE SPIKED TO COLUMNS WITH 6 INCH IRON SPIKES 9 OF WHICH ARE TO BE PUT IN EACH SQUARE FOOT.

NOTE

Soundings are expressed in feet and are referred to a stage of water which corresponds to a reading of 2.3 feet on the Memphis gage. Work done since last report is indicated by heavy full lines and previous work by heavy broken lines.

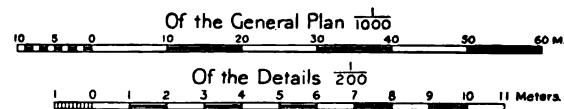
The surface of the lake is 400 feet above mean tide level.



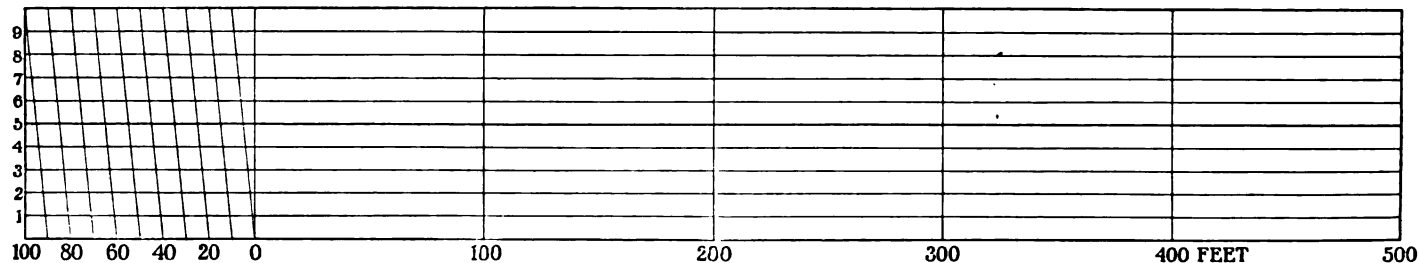
Scale: 1 inch to 1 mile



SCALES

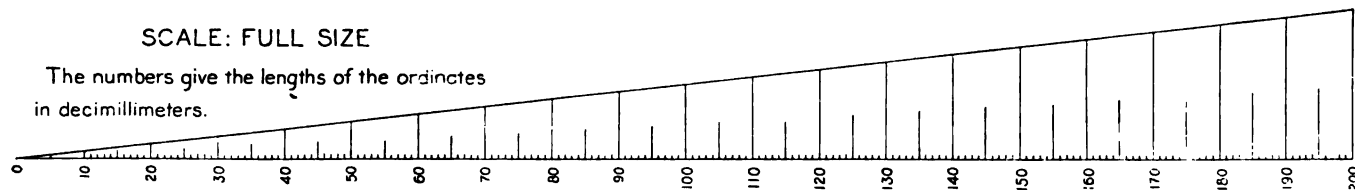


SCALE 1:1000

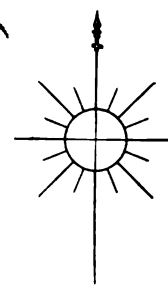
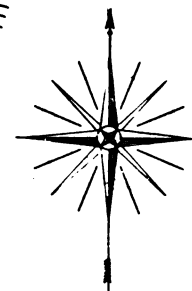
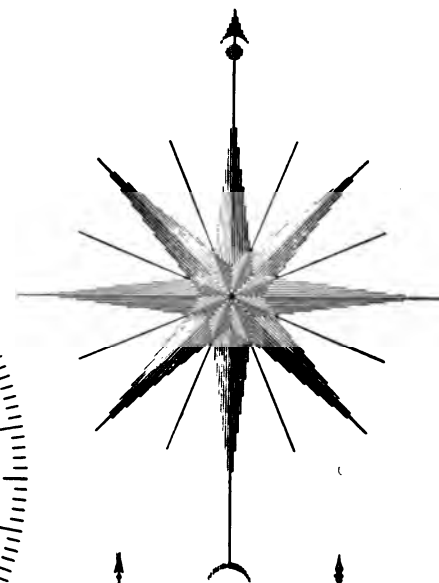
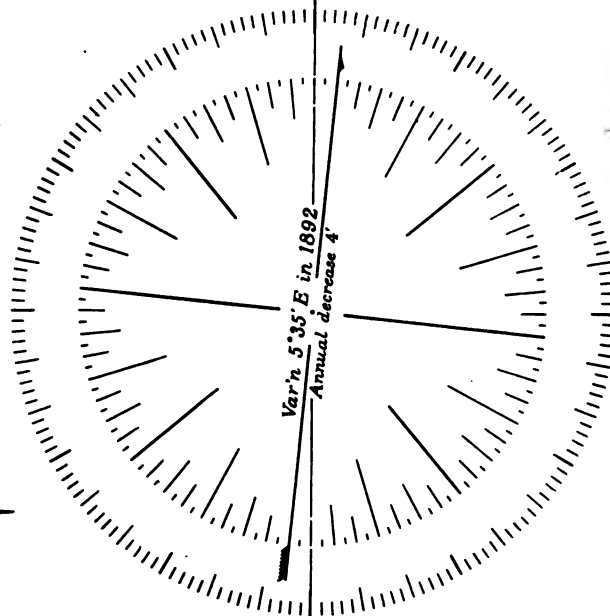
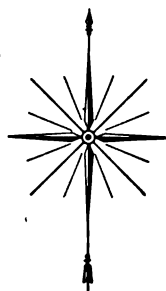
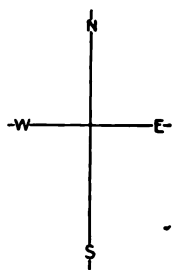
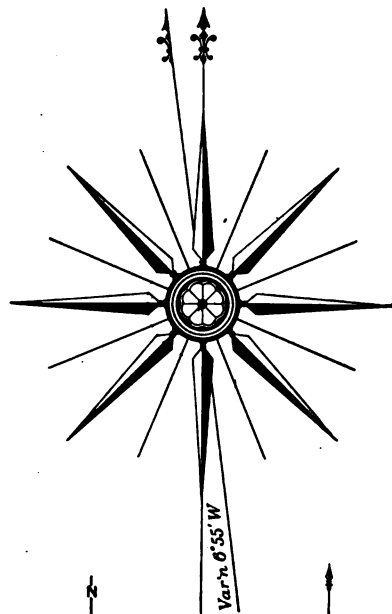


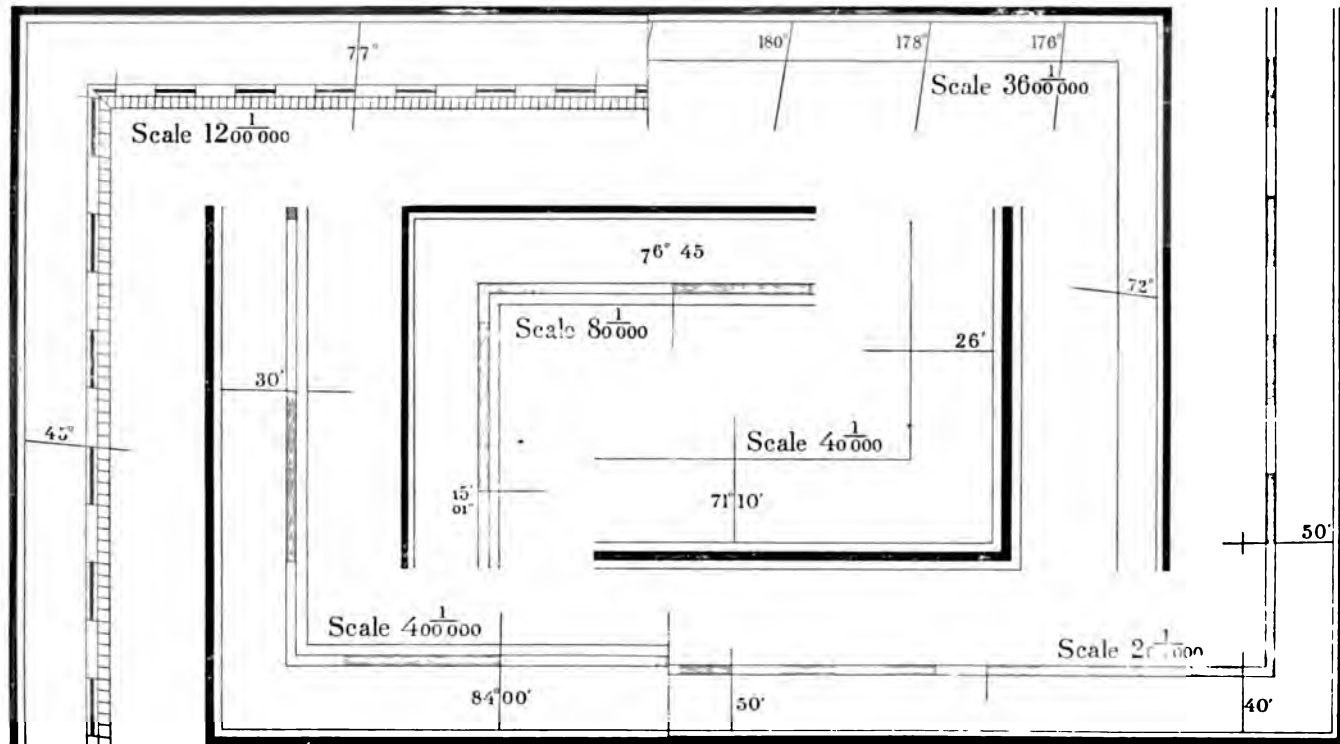
SCALE: FULL SIZE

The numbers give the lengths of the ordinates
in decimillimeters.



Meridians





a b c d e f g h i j k l m n o p q r s t u v w x y z &

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

.. Benj S Hbbell Architect 1001 Garfield Bvilding ..

.. Cleveland Ohio ..

ABBCDEFGHIJKLMMNOPPPQRRSTUVWXYZ

THE WOMAN'S TEMPLE, CHICAGO, 1892

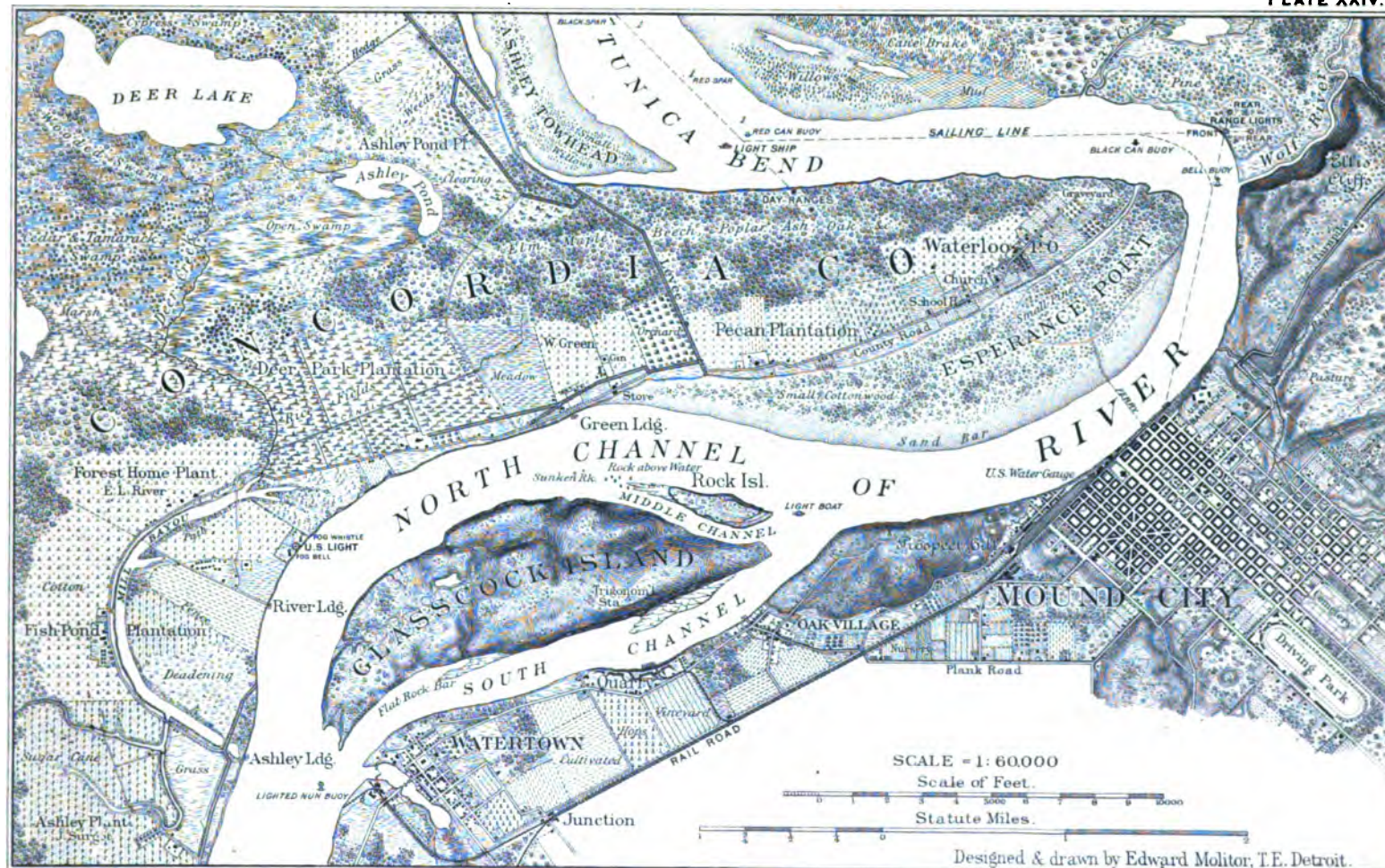
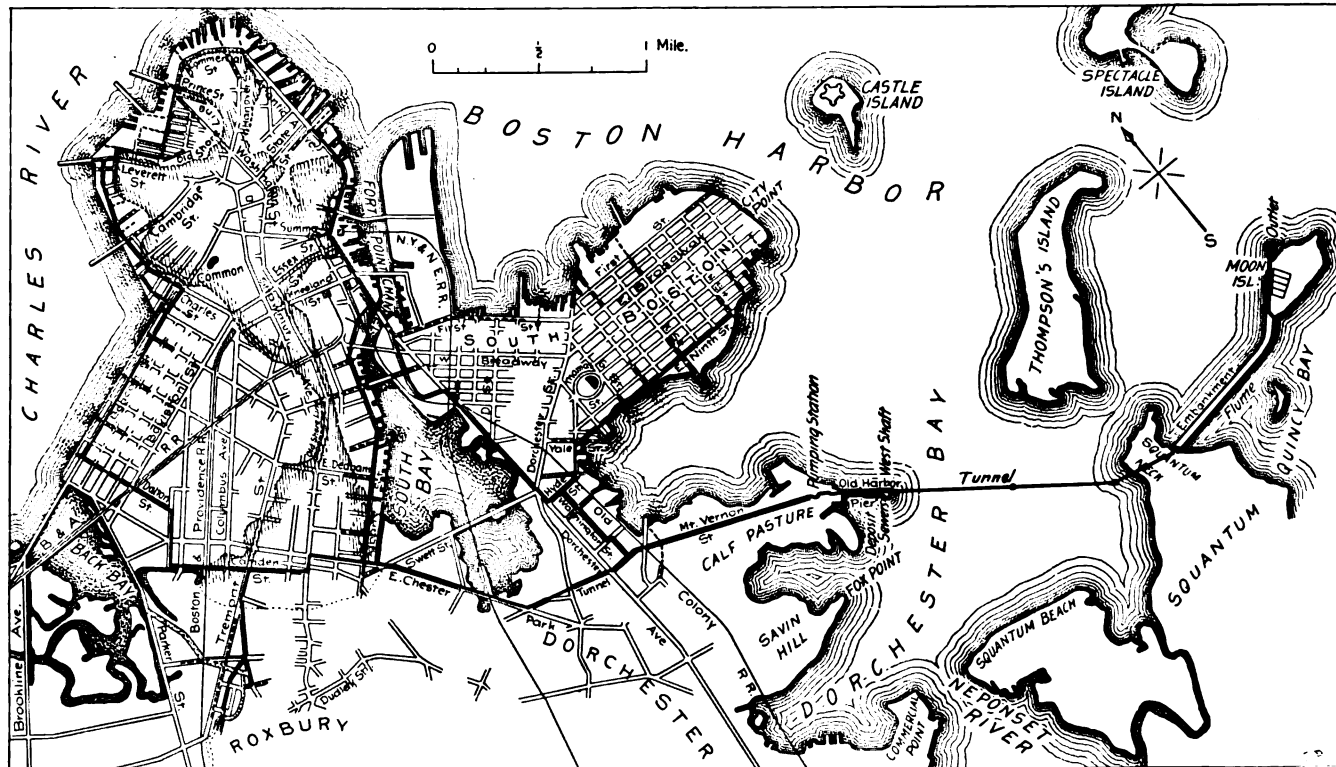




PLATE XXV



U.S.COAST SURVEY

PLATE XXVI

Classification and Rules for the miscellaneous lettering of names &c. on the map,
not connected with title or notes.

GAUGE OF LETTERS

TO BE USED ON THE PUBLICATION SCALES OF

$\frac{1}{80\,000}$ $\frac{1}{60\,000}$ $\frac{1}{50\,000}$

LINE
Height of Letters
in Decimillimetres

CLASS I. All names and words connected with LAND to be vertical, thickness $\frac{1}{8}$ of height.

1	40 (a)	REGIONS, 1st. Class, MAINE, CAPE COD, LONG I.
2	30	REGIONS, 2nd. Class, NANTUCKET, STATEN I., EDISTO I.
3	20 (b)	Islands, Capes, Points, 1st. Class, Forming Harbors and known as Land Marks.
4	15	Islands, Capes, Points, 2nd. Class, do. do. do.
5	10	Islands, Points, Beaches, Necks, Hammocks, Rocks, Marshes, Of only local importance.
6	6	Islands, Ponds, Beaches, Necks, Hammocks, Rocks, Marshes, Of only local importance.

7 30 CITIES, 1st. Class, NEW YORK, BOSTON, NEW ORLEANS.

8 25 CITIES, 2nd. Class, PORTLAND, CHARLESTON, MOBILE.

9 20 TOWNS, 1st. Class, NEWPORT, ST. AUGUSTINE, PENSACOLA.

10 15 TOWNS, 2nd. Class, STONINGTON, NEW CASTLE, BEAUFORT.

11 10 VILLAGES AND SHADED SETTLEMENTS.

12 10 Cross Roads, Landings, Places not thickly settled.

13 8 Bridges, Rail Roads, Docks, Plantations &c.

14 Note. The gauge of height refers to the Small Letters, where the name or word is not in full capitals.

The proportion of Small Letters is $\frac{2}{3}$ the height of the capital letter beginning the word.

15 (a) Regions requiring it may have a letter larger than 40 metres, but always subordinate to the main line of the title.

16 (b) Where size or importance of the feature requires it, Capitals for Islands of the heights of 12, 15, 20 and 25 metres may be used. Small roman 12 metres high may also be used for Islands, Capes, Points &c. where the size will not admit of 15 metres high.



GAUGE OF LETTERS
TO BE USED ON THE PUBLICATION SCALES OF

$\frac{1}{80\,000}$ $\frac{1}{60\,000}$ $\frac{1}{50\,000}$

CLASS II. *All names and words connected with WATER to be slanting Capital and Italics, thickness $\frac{1}{8}$ of height, inclination 3 parts of base to 8 of height.*

LINE
Height of Letters
in Decimillimetres.

17 40 * *REGIONS, 1st. Class, ATLANTIC O., CHESAPEAKE B.*

18 30 *REGIONS, 2nd. Class, VINEYARD SOUND, MATAGORDA BAY.*

Forming and containing harbors and anchorages.

19 20 * *RIVERS, BAYS, COVES, ROADS, HARBORS, 1st. Class.*

20 15 *RIVERS, BAYS, COVES, HARBORS, 2nd. Class.*

21 10 *RIVERS, BAYS, COVES, HARBORS, 3rd. Class.*

22 8 *RIVERS, BAYS, COVES, HARBORS, 4th. Class.*

Not navigable and not forming harbors.

- 23 20 * *Rivers, Creeks, Ponds, Shoals, Bars, Spits, 1st. Class.*
- 24 15 *Rivers, Creeks, Ponds, Shoals, Bars, Spits, 2nd. Class. Ledges, 1st. Class.*
- 25 10 *Rivers, Creeks, Ponds, Coves, Shoals, Bars, Spits, 3rd. Class. Ledges, 2nd. Class.*
- 26 8 *Creeks, Ponds, Coves, Shoals, Bars, Spits, 4th. Class. Ledges, 3rd. Class.*

CLASS III. All names and words connected with NAVIGATION to be BLOCK LETTERS
Thickness $\frac{1}{4}$ of height.

- 27 10 [VERTICAL] LIGHT HOUSES, SEACONS, FOG BELLS, OBJECTS ON LAND USED FOR RANGES.
- 28 15 [SLANTING] CHANNELS, 1st. Class.
- 29 12 DO. CHANNELS, 2nd. Class. COMPASS BEARINGS (N.W. & W.). CURRENT STATIONS.
- 30 10 DO. CHANNELS, 3rd. Class. LIGHT SHIPS, BELL BOATS, BUOYS, VIEW STATIONS AND NOS.
- 31 8 DO. SPINDLES, VELOCITIES OF CURRENTS.

32 Note. The gauge of height refers to the Small Letters, where the name or word is not in full capitals.
The proportion of Small Letters is $\frac{1}{4}$ the height of the capital letter beginning the word.

33 * Regions and Rivers requiring it may have letters larger than 40 and 20 metres, but always subordinate to the main line of the title.

Thickness of letter $\frac{1}{8}$ of height. Slope $2\frac{1}{2}$ parts of base to 8 of height.									
LINE	DECIMILLI-METRES	ENGRAVING			ENGRAVING				
34	60	DIVISION			DIVISION				
35	55	CAPITOL			CAPITOL			Slope 3 to 8	
36	50	HARBOR			HARBOR			$\frac{1}{8}$ CHANNEL	
37	45	ISLANDS			ISLANDS			LIGHT HOUSE	
38	40	RIVERS			RIVERS			LIGHT HOUSE	
39	35	SOUNDINGS			SOUNDINGS			$\frac{1}{4}$ CHANNEL	
40	30	DIRECTIONS			DIRECTIONS			LIGHT HOUSE	
41	25	POINTS	POINTS	Points	Points	POINTS	POINTS	LIGHT HOUSE	
42	20	CREEKS	CREEKS	Creeks	Creeks	CREEKS	CREEKS	$\frac{1}{4}$ CHANNEL	
43	15	CHANNELS	CHANNELS	Channels	Channels	CHANNELS	CHANNELS	LIGHT HOUSE	
44	12	SHOALS	SHOALS	Shoals	Shoals	SHOALS	SHOALS	LIGHT HOUSE	
45	10	SPINDLES	SPINDLES	Spindles	Spindles	SPINDLES	SPINDLES		
46	8	COMPASS	COMPASS	Compass	Compass	COMPASS	COMPASS		
47	6								



GENERAL CHART OF ALASKA

(Polyconic Projection)

Scale 3660000

Compiled from United States and Russian Authorities

ALL SOUNDINGS IN FATHOMS. HEIGHTS IN FEET

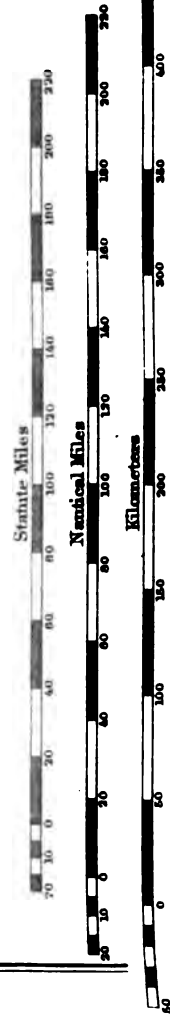
Published at Washington, D.C.

April 1906

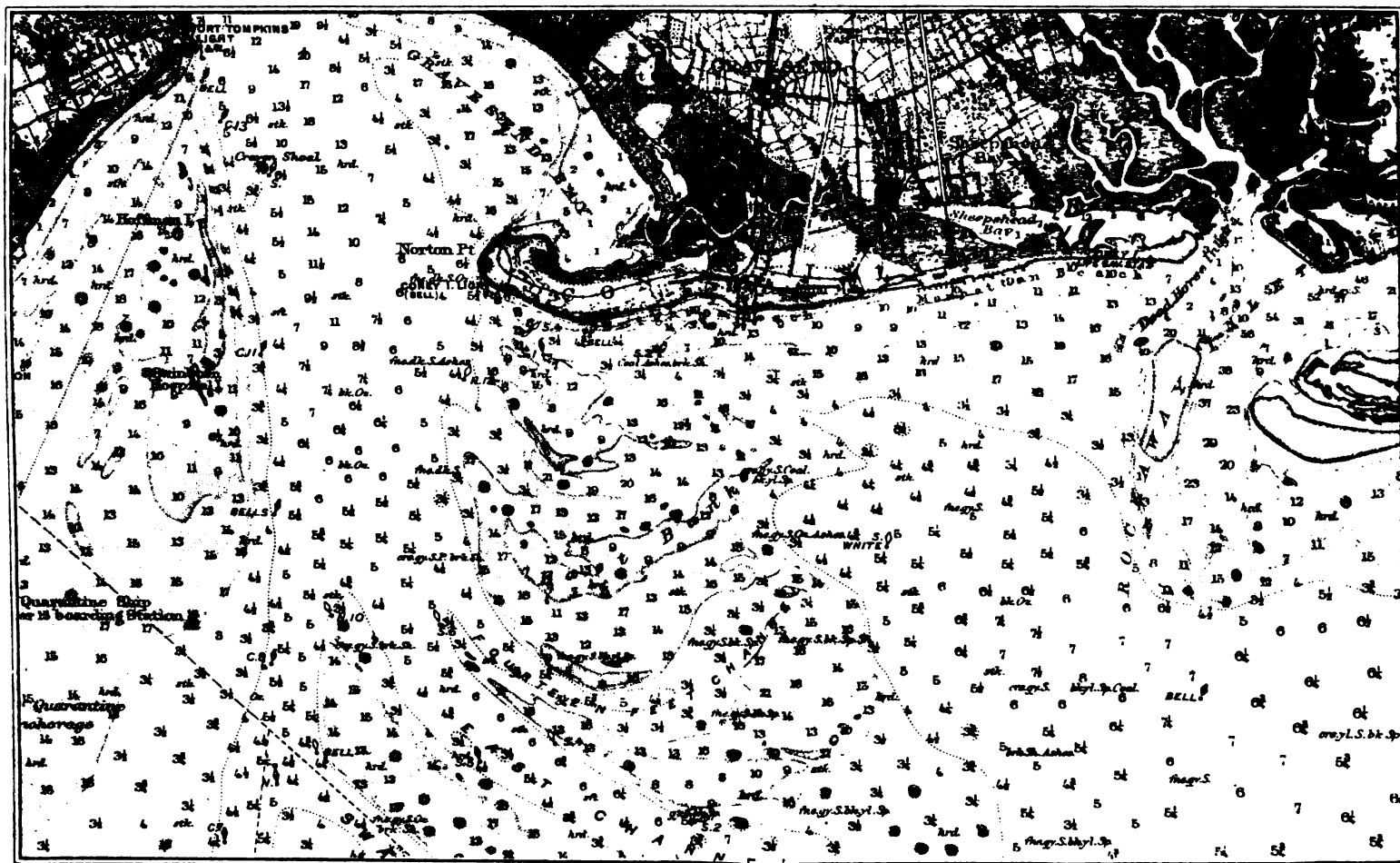
BY THE U.S. COAST AND GEODETIC SURVEY

O. H. Tietmann, Superintendent.

(Date of first publication 1890)







LETTERING.

CIVIL DIVISIONS.

States, Counties, Townships, Capitals, and Principal Cities,

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

Towns and Villages, and Localities.

a b c d e f g h i j k l m n o p q r s t u v w x y z

HYDROGRAPHY

Oceans, Seas, Gulfs, Lakes, Rivers, and Bays, Falls, Rapids,

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

Creeks, Brooks, Springs, small Lakes, Ponds, Marshes, and Glaciers,

a b c d e f g h i j k l m n o p q r s t u v w x y z

HYPSOGRAPHY

Mountains, Plateaus, Lines of Cliffs, and Canyons, Peninsulas, Capes, Plains,

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

Peaks, small Valleys, Canyons, Islands, and Points.

a b c d e f g h i j k l m n o p q r s t u v w x y z

PUBLIC WORKS

Railroads, Tunnels, Bridges, Ferries, Wagon-roads, Trails, Fords, and Dams,

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

MARGINAL LETTERING

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

a b c d e f g h i j k l m n o p q r s t u v w x y z

1 2 3 4 5 6 7 8 9 0

CONTOUR NUMBERS

1234567890 1234567890

*Gage of Letters
(in Decimillimeters.)*

5	-----
6	-----
7	-----
8	-----
9	-----
10	-----
12	-----
13	-----
14	-----
15	-----
18	-----
20	-----
22	-----
25	-----
30	-----
35	-----
40	-----
45	-----
50	-----
55	-----
60	-----

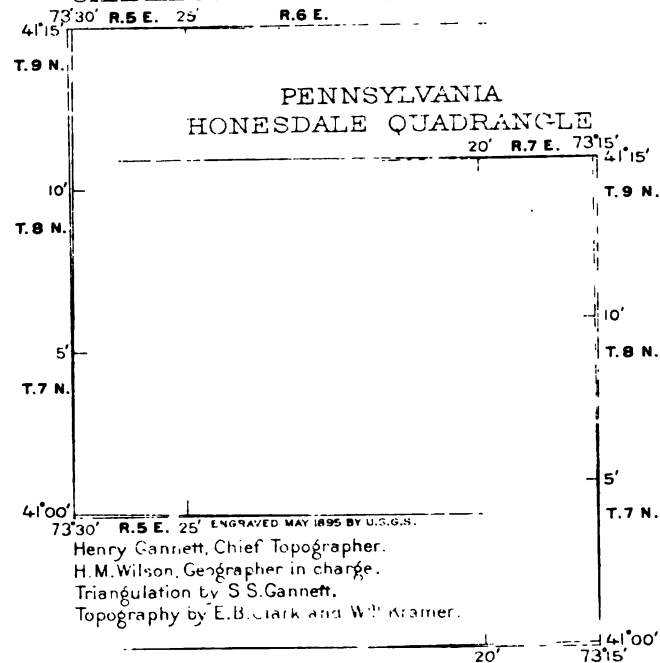
CIVIL DIVISIONS

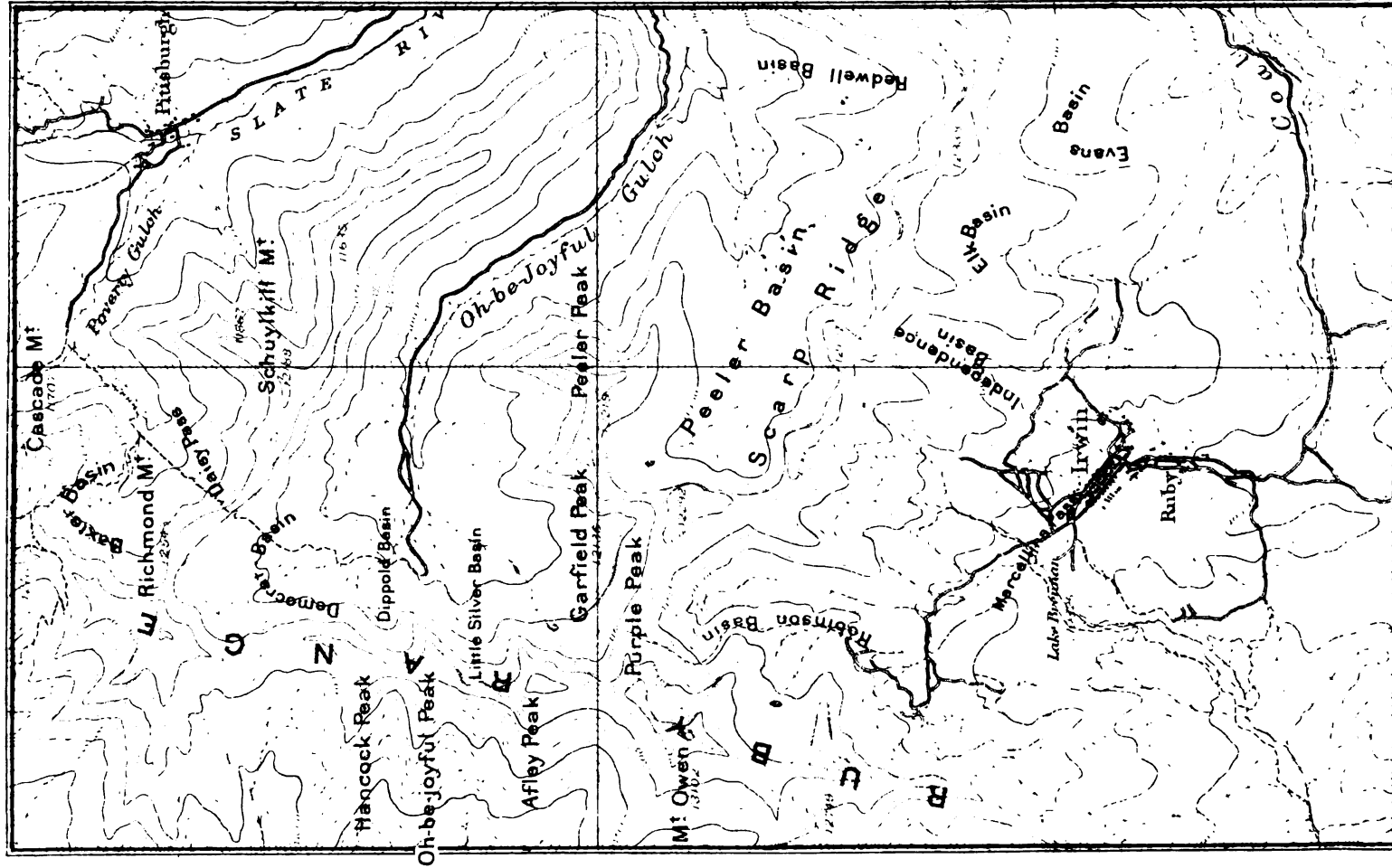
State and National -----

County -----

MISCELLANEOUS

U. S. GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR





A PORTION OF THE ELK MOUNTAINS, COLORADO.

SURVEY OF

THE MISSISSIPPI RIVER

Made under the direction of the

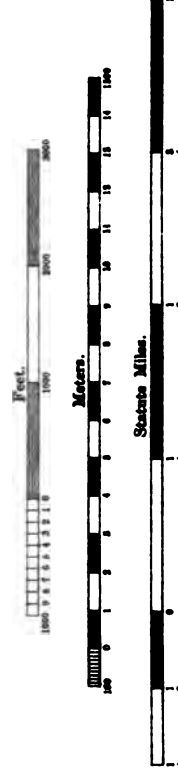
MISSISSIPPI RIVER COMMISSION.

CHART NO 143

Projected from a Trigonometrical Survey

Made in 1891.

SCALE = 1:30,000.



AUTHORITIES.

The Topographical and Hydrographical Surveys and Secondary Triangulation were executed under the supervision of Capt. Oarl F. Palfrey, Corps of Engineers, U. S. A., Secretary Mississippi River Commission. The *Precise Levels* were run under the direction of First Lieutenant Smith S. Leach, Corps of Engineers, U. S. A., Secretary Mississippi River Commission.

The office mapping was done under the supervision of First Lieutenant Geo. A. Zinn, Corps of Engineers, U. S. A., Secretary Mississippi River Commission.

Latitudes and Longitudes, are derived geodetically from the Cairo Astronomical Station determined in 1878 by Captain H. M. Adams, Corps of Engineers, U. S. A., and First Lieutenant D. W. Lookwood, Corps of Engineers, U. S. A.

Secondary Triangulation and Stone Lines, in 1891, Assistant Engineer Chas. W. Stewart, Chief of Party.

Precise Levels, in 1891, by Assistant Engineers J. B. Johnson and O. W. Ferguson. *Topography and Hydrography*, in September 1893, Assistant Engineer A. T. Morrow, Chief of Party.

Ordinary Levels, by M. I. Powers, Jr., and F. G. Ray.

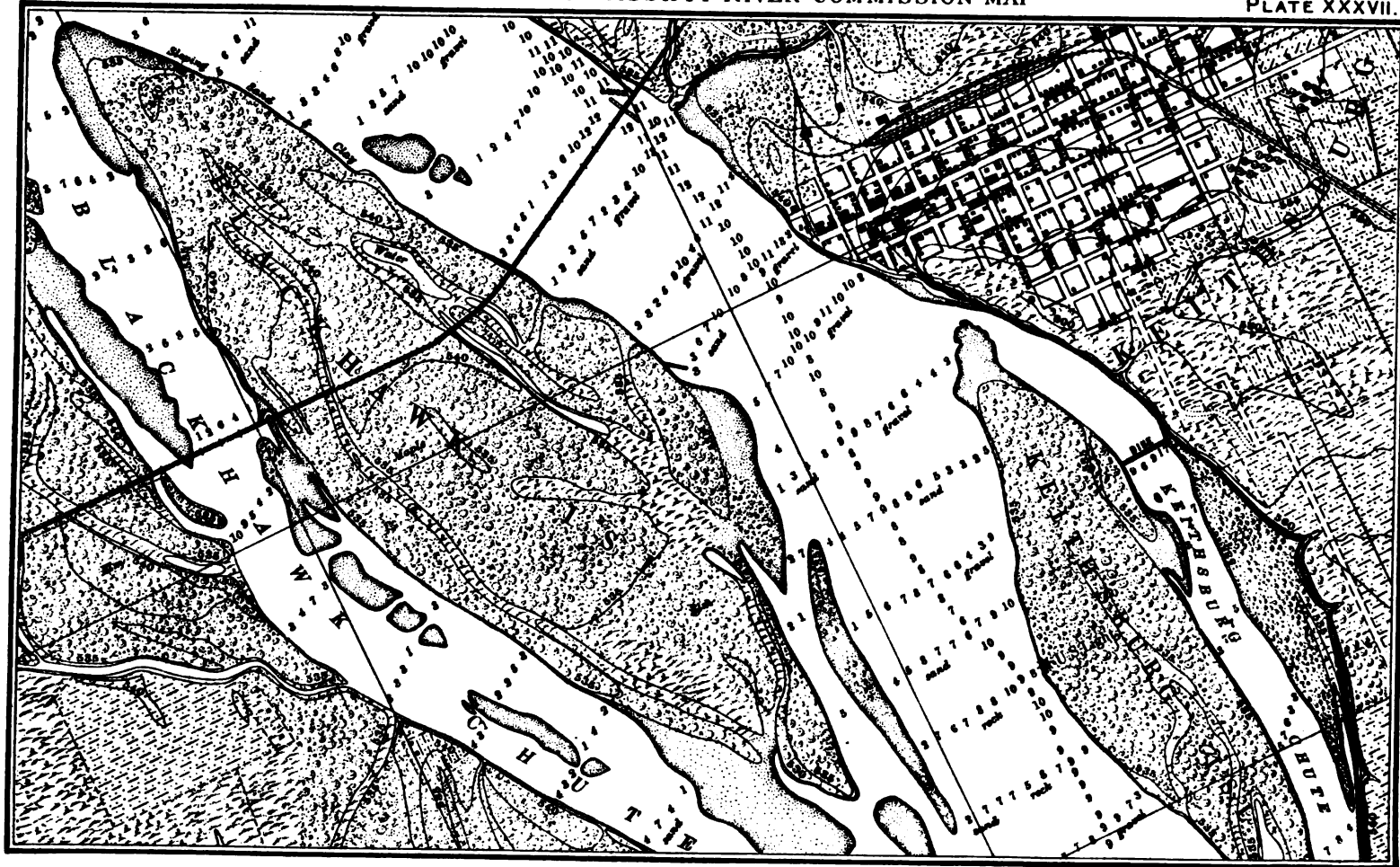
Topography, by W. G. Oomber, G. H. French, E. L. Harman, H. Dunaway, E. J. Thomas, C. L. Ockerson and O. K. Axtell. Field platting by C. A. Bondla.

Hydrography, by T. C. Hookridge and C. M. Talbert.

Office Reduction and Drawing, under the direction of J. A. Ockerson, Assistant Engineer in charge of Surveys; by Chas. W. Stewart, W. G. Oomber, E. L. Harman, H. Dunaway, E. J. Thomas, C. L. Ockerson, Geo. H. Wolbrecht, Chester B. White, C. R. Appiano and H. A. H. d'Ally.

PORTION OF MISSISSIPPI RIVER COMMISSION MAP

PLATE XXXVII.



Scale: 1. 20,000

LITHO BY CHAS. HART, 36 VESEY ST. N. Y.

MECHANICAL SIGNS AND LETTERS.

SURVEY OF THE NORTHERN AND NORTHWESTERN LAKES.

PLATE XXXVIII.

Made in obedience to Acts of Congress,
and orders from the
HEADQUARTERS OF THE CORPS OF ENGINEERS, WAR DEPARTMENT.

CHART OF LAKE SUPERIOR.

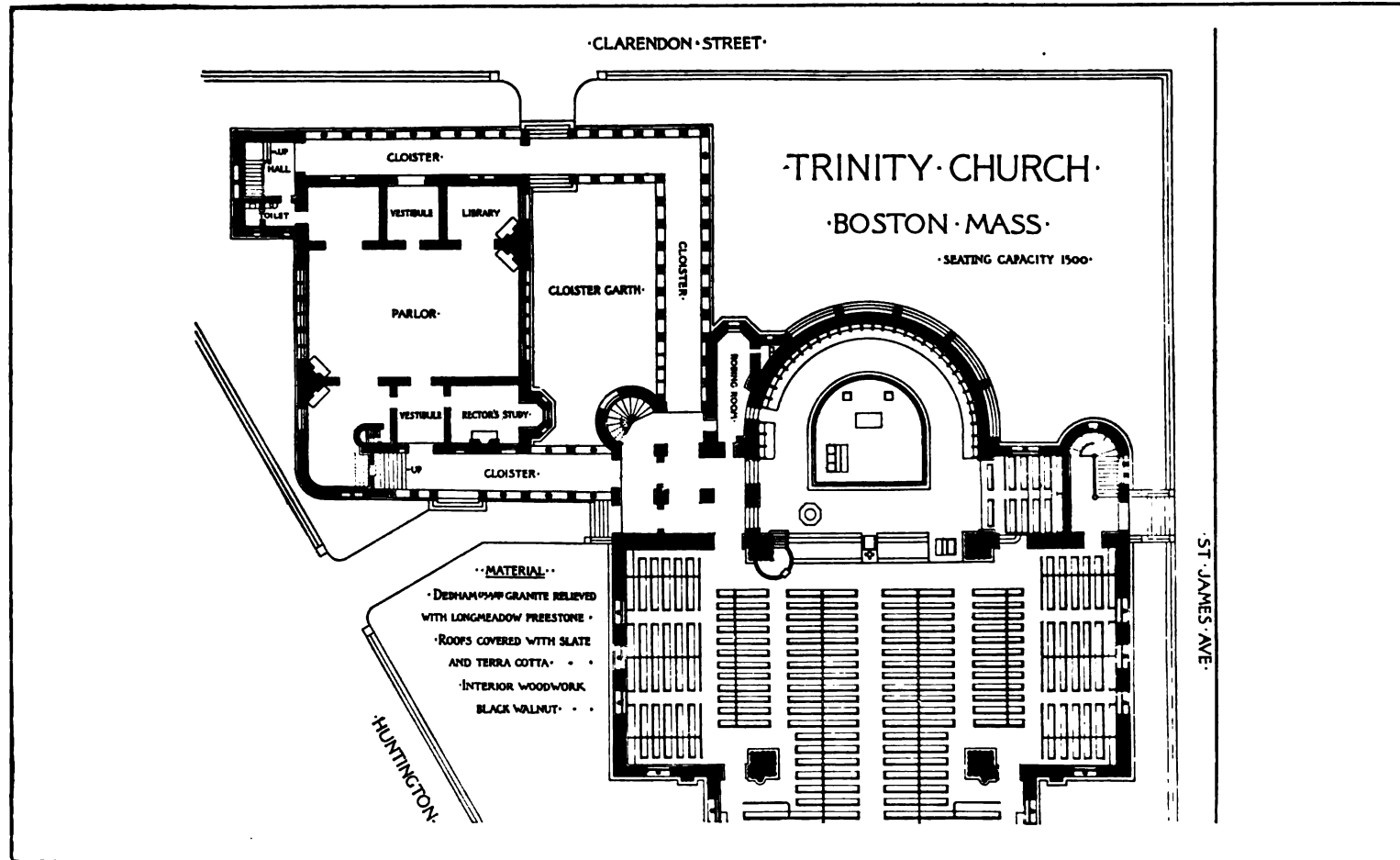
Compiled under the direction of
Colonel O.M. POE, Corps of Engineers, Bvt. Brig. Gen. U. S. A.

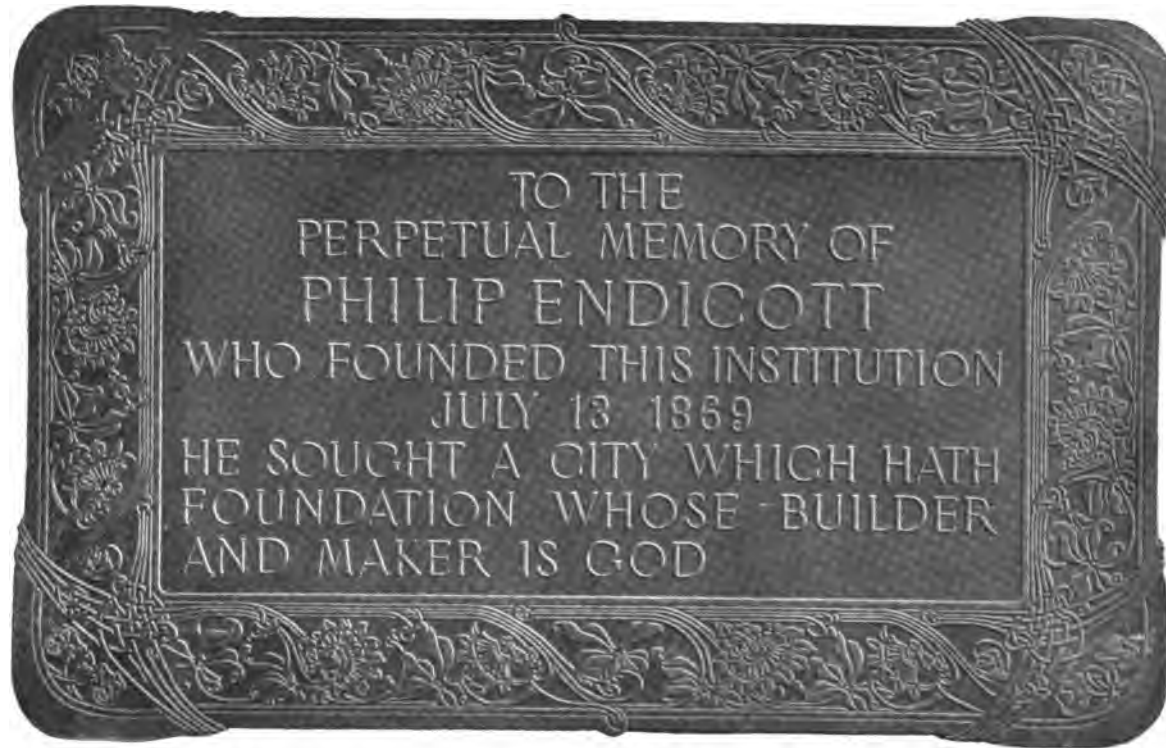
From U. S. Surveys made between the years
1855 and 1895,

The Canadian Shore from British Admiralty Charts and other Sources.

Published in 1895.

A. Horn & Co. Lith. Baltimore





ROMAN.

ABCDEFGHIJKLMNOPQRSTUVWXYZ&
 1234567890 abcdefghijklmnopqrstuvwxyz
 Balanced Cantilever Derrick MODERN CLASS

ROMAN OLD STYLE.

ABCDEFGHIJKLMNOPQRSTUVWXYZ&
 1234567890 abcdefghijklmnopqrstuvwxyz
 CITY HALL Granite Capital COURT HOUSE

ITALIC.

a b c d e f g h i j k l m n o p q

r s t u v w x y z

Section of the Southeastern Corridor

ITALIC OLD STYLE.

a b c d e f g h i j k l m n o p q

r s t u v w x y z

Second Floor Plan Dome

TYPE SPECIMENS.

PLATE XLII.

CUSHING.

✓ A B C D E F G H I J K L M N O P Q R S T

U V W X Y Z & 1 2 3 4 5 6 7 8 9 0

a b c d e f g h i j k l m n o p q r s t u v w x y z

CHICAGO SANITARY DISTRICT

AND DESPLAINES VALLEY

Ratio of Sediment to Water by Weight

CUSHING ITALIC.

A B C D E F G H I J K L M N O P Q R S T

U V W X Y Z & 1 2 3 4 5 6 7 8 9 0

a b c d e f g h i j k l m n o p q r s t u v w x y z

STORM WATER OUTLET

SIXTEEN-WHEELED GUN TRUCK

Graphical Computation of Discharge

ORLITO.

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z &

1 2 3 4 5 6 7 8 9 0 STANDARD BOX CULVERT

ORLITO, No. 2.

✓ A B C D E F G H I J K L M N O P Q R S T U V W X Y Z & 1 2 3 4 5 6 7 8 9 0

NORTH WING OF MAIN BUILDING TOWN HALL

FULL-SIZE DETAILS OF MAIN CORNICE 1895

TYPE SPECIMENS.

PLATE XLIII.

BLANKAY.

ABBBCDEFGGHIJKLMMNNNOOPQRSSTUVWXYZ&
1234567890 LAKESIDE COTTAGE GATE LODGE
GOLDEN ARCH OVER STAIRS AT THE ENTRANCE

OUTING.

ABCDEFGHIJKLMNPOQRSTUVWXYZ 1234567890
ELECTRIC SERVICE UNIQUE GRILLE FANCY BALCONY

ART GOTHIC.

ABEDEF GHIJKL MNOPQR STUVW XYZ& abedefghijklmnopqrstuvwxyz
1234567890 Fireplace Nook in Parlor Uncovered Piazza Dining Room Mantel

DYNAMO.

ABCDEFGHIJKLMNPOQRSTUVWXYZ& abcdefghijkl
mnopqrstuvwxyz HIGH SCHOOL BUILDING Terra Cotta Details

DE VINNE.

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z &
 a b c d e f g h i j k l m n o p q r s t u v w x y z 1 2 3 4 5 6 7 8 9 0
 LIBERAL ARTS BUILDING Comparative Mortality

QUAINT OPEN.

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z & 1 2 3 4 5 6 7 8 9 0
 COUNTRY RESIDENCE DEPOT CARRIAGE CONCOURSE

OLD STYLE ANTIQUE, No. 2.

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z &
 1 2 3 4 5 6 7 8 9 0 MATTRESS WAYS SPUR DIKE

VICTORIA ITALIC.

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z 1 2 3 4 5 6 7 8 9 0
 TYPICAL SECTIONS OF LEVEES LUNITIDAL INTERVALS

HELICOIDAL ARCH	1 2 3 4 5 6 7 8 9 0	2500 HP
EXHAUST VALVE	<i>28 CARROLL AVENUE</i>	
HIGH POWER	<i>Permanent Bench Mark</i>	
MACADAM PAVEMENT	UNIVERSITY PARK	
High Water Readings at Memphis	STEAM SNAG BOAT	
EXECUTIVE MANSION	Permissible Unit Stresses	
CONCRETE MIXER	GRAVEL DUMP CAR	
MINE HOISTING ENGINE	WEST ABUTMENT	
RAILROAD LOCATION	COMPOUND ENGINE	

DEPARTMENT OF PUBLIC WORKS
BUREAU OF WATER

MAP OF
PHILADELPHIA

No. 2

SHOWING

DISTRICTS OF DISTRIBUTION

arranged in accordance with the

TOPOGRAPHY OF THE CITY

and the

PRESENT AND PROPOSED RESERVOIRS

from which they are to be supplied

SCALE OF FEET

SCALE OF MILES

[The map containing the subject-matter of the above title accompanied the Annual Report of 1892.]

PROFILE
OF THE
MARITIME CANAL
OF
NICARAGUA

1890

DISTANCE FROM OCEAN TO OCEAN 169.4 MILES
CANAL 26.8 MILES
LAKE, RIVER AND BASINS 142.6 MILES
LENGTH OF SUMMIT LEVEL 153.2 MILES
ELEVATION OF SUMMIT LEVEL ABOVE SEA 110 FEET
NUMBER OF LOCKS SIX

Rapid Transit Commission

Plan showing

Proposed Central Routes
and
Suburban Connections

Boston, Mass.

March, 1892

Scale of Feet

Scale of Meters

TYPE SPECIMENS.

PLATE XLVIII.

NOTES.

The maximum rainfall is taken as 1.5 inches per hour, or 1.512 cubic feet per second per acre.

Of the blocks on this map (not counting streets) 0.24 cubic feet per second per acre is supposed to reach the sewers from the roofs and plumbing of houses, or about one-sixth of the total area of the lots.

Of all outlying acreage one-third is supposed to be occupied by streets, courts, and alleys, and one-sixth of each lot is supposed to be occupied by buildings; or, that $\frac{1}{3} \times \frac{2}{3} \times 1.512 = 0.168$ cubic feet per second per acre reaches the sewers.

NOTES.

Contour lines and elevations are referred, in feet, to the mean Gulf level and the contours are 3 feet apart.

Latitudes and longitudes on this map depend on those of the Cairo astronomical station as determined by the U. S. Corps of Engineers.

The shore line is given at a stage of water which corresponds to a reading of 17 feet on the U. S. Engineer's gage, Cairo, and is plotted from surveys made in 1876-'77 by the U. S. Corps of Engineers.

The boundary between Kentucky and Illinois is along the northwestern shore of the Ohio River.

All possible varieties of expression being at the command of the skillful architect, the dominant expression of every building must be consistent with and determined by its use and environment.

NOTES.

THE SHADED AREA INDICATES THE SURFACE BELOW TWENTY FEET ABOVE CHICAGO DATUM (LOW WATER OF LAKE MICHIGAN, 1847).

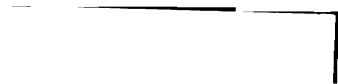
The unshaded area, along the river, between Romeo and Joliet, is below Chicago datum.

VERTICAL VELOCITY CURVES.

Computed from mean observed velocities expressed in revolutions of meter per second. Depth regarded as unity. Velocity per second equals 4.168 revolutions per second plus 0.084.

The finished floor is sometimes laid before the interior finish is put in place, but in the best practice it is not laid until all other work is in place and finished.

1778 078



1
1
1

1
1

1
1
1

[illegible]

DEMCO 38-297

D. PG.

1984

• INSTRUCTIONS, MASS.



3 2044 029 615 705

Jacoby

841

